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Vinyl Chloride: Relief Valve Standard

NESHAP

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Vinyl Chloride: Relief Valve Standard

Emission Standards and Engineering Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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1.0 INTRODUCTION

National emission standards for hazardous air pollutants (NESHAP) are developed under the authority of Section 112 of the Clean Air Act. The national emission standard for vinyl chloride (VC) was proposed on December 24, 1975 (40 FR 59532) and promulgated on October 21, 1976 (41 FR 46559). The standard covers emissions of VC from sources in plants producing ethylene dichloride (EDC), VC, and polyvinyl chloride (PVC). This report presents an analysis of one currently regulated source of VC emissions at EDC/VC and PVC plants--relief valve discharges. The purpose of the analysis presented here is to characterize relief valve discharge performance by plants under the current standard. The analysis was performed to investigate the feasibility of restructuring the relief valve discharge standard based on redefined numerical limits.

Information on relief valve discharge performance was obtained both from EPA Regional Offices and industry. Section 2.0 describes the data sources used in the analysis. Relief valve discharge performance by the industry is summarized in Section 3.0. The techniques used by industry to control relief valve discharges are described in Section 4.0. Causes and preventability of relief valve discharges are discussed in Section 5.0. Finally, Section 6.0 presents the methodology used to characterize relief valve discharge performance from collected data.

2.0 DATA BASE DESCRIPTION

Data from 44 of the 49 plants in the vinyl chloride industry were used to analyze relief valve discharge performance under the current standard. Included in the data base are 30 of 35 PVC plants representing 92 percent of PVC production and all 14 EDC/VC plants. Relief valve discharge data were obtained from two primary sources: EPA Regional Offices and the Vinyl Institute. Descriptions of these two data sources follow

2.1 VINYL INSTITUTE DATA

Relief valve discharge performance data were supplied by the Vinyl Institute (VI) for 29 of their member plants (19 PVC plants and 10 EDC/VC plants). Data were supplied for a 25 month period from 8/81 to 8/83. Information available in the VI data were:

- number of discharges/100 batches of resin produced (PVC plants only)
- number of discharges/MM lb product
- number of discharges
- lbs of VC discharged/100 batches of resin produced (PVC plants only)
- lbs of VC discharged/MM lb production
- lbs of VC discharged

All data supplied were on a monthly basis (i.e., discrete totals for each of the 25 months).

The data were divided into discharges from PVC plants and discharges from EDC/VC plants. Data for PVC plants were separated into reactor and nonreactor discharges. Reactor discharges were further separated by resin type (i.e., suspension, dispersion, latex, bulk) and reactor size, large or small. Reactors with a volume of greater than 10,000 gallons are defined as large for the purposes of this study.

2.2 REGIONAL COMPLIANCE DATA

Relief valve discharge compliance data representing 23 PVC plants and 13 EDC/VC plants were obtained from EPA Regional Offices (Regions II, V, and VI) and one state agency (Texas). Data were obtained in the form of either 10-day reports or summaries of 10-day reports. Ten-day reports are compliance reports that plants are required under the current VC standard to submit within ten days of a relief valve discharge incident. Information typically included in the 10-day reports are:

- date of discharge
- estimated quantity of VC discharged
- source of discharge
- cause of discharge
- measures taken to prevent the discharge
- measures taken to prevent recurrence

Ten-day reports were obtained for the period 1978-1983. This represents the entire compliance period since 1978. In total, data were compiled for 458 discharges from PVC plants and 142 discharges from EDC/VC plants. The total amount of VC emissions associated with these discharges are 1.1 MM lbs and 0.3 MM lbs for PVC and EDC/VC plants, respectively.

2.3 COMPARISON OF THE VINYL INSTITUTE AND REGIONAL COMPLIANCE DATA BASES

Exclusive use of either one of the two primary data sources would have omitted key information needed in the analysis of relief valve discharge performance. For instance, the regional compliance data included information on causes and estimated lbs of VC discharged for individual discharges. This information was not made available by the VI in their data. Regional data was also available for a five and one-half year period versus 25 months of data supplied by the Vinyl Institute. However, the VI provided data on actual monthly production and batch frequencies by plants for months when discharges occurred. Furthermore, they classified the relief valve discharge data by source (i.e., reactor vs. nonreactor) and resin type for PVC plants. The regional compliance data for PVC plants did not always include information on source and resin type for individual discharges.

In general, where data were obtained for the same plants and period from both sources, there appears to be general agreement. For instance, comparison of the numbers and estimated pounds of discharges reported in each data base indicate close agreement.

3.0 SUMMARIES OF RELIEF VALVE DISCHARGE PERFORMANCE DATA

This section presents the relief valve discharge performance data for PVC and EDC/VC plants that were compiled from the data sources described in Section 2. Several formats were selected for expressing relief valve discharge performance. Where appropriate, different data formats were used for PVC plants and EDC/VC plants. For each of the selected formats, data were compiled on an annual basis. Because limits based on rolling averages may be selected for incorporation into the VC standard, the tabulated data in some tables are compiled on an annual basis but with overlap between the successive periods. In these tables, each new one-year period picks up the next 6 calendar months and drops the preceding 6 calendar months so that the tabulated values represent annual plant performance rolling every six months. Other tables present data in a straight year by year format. Tabulated summaries of relief valve discharge performance data are presented for PVC and EDC/VC plants in the following sections. The basis for each of the summary tables is discussed in Section 6.

3.1 RELIEF VALVE DISCHARGE PERFORMANCE BY PVC PLANTS

The study of relief valve discharge performance by PVC plants with batch production processes was separated into two categories: reactor discharges and nonreactor discharges. Reactor discharges were further separated by resin type (i.e., suspension, dispersion, latex, and bulk) and by reactor size, large or small. (Reactors larger than 10,000 gallons were defined as large.) Relief valve discharge performance associated with the continuous solution process for PVC was not separated according to reactor and nonreactor discharges. Four formats were used to express relief valve discharge performance by PVC plants. The four formats are:

- number of discharges
- number of discharges/100 polymerization batches
- lbs of VC discharged
- lbs of VC discharged/MM lbs of PVC production

As discussed in Section 2, relief valve discharge data from two independent sources were studied.

3.1.1 Vinyl Institute Data Summaries

A summary of the relief valve discharge performance data collected by the Vinyl Institute from member companies is given in Table 3-1. For each of the PVC producers surveyed, relief valve discharge performance data are summarized in each of the four formats for three 12-month periods between 8/81 and 7/83. The Vinyl Institute data for individual plants were initially separated for large and small reactors. However, preliminary studies indicated no significant difference in the frequency and size of discharges between large and small reactors. Thus, discharges from large and small reactors are combined in Table 3-1.

3.1.2 Regional Compliance Data Summaries

Summaries of regional compliance data for PVC plants are given in Tables 3-2 through 3-5 for each of the four formats. Regional compliance data are summarized in each of the tables for 12-month periods between 1978 and 1983, where 10-day reports are available.

Preliminary studies of the regional compliance data indicated no significant difference for large reactor performance versus small reactor performance in the number of releases/100 batches format. Therefore, large and small reactor discharges are combined in Table 3-2.

Data were unavailable to accurately estimate PVC production by resin type at individual plants. Therefore, regional compliance data (in the format of lbs of VC discharged/MM lbs PVC) are not presented by resin type.

3.2 RELIEF VALVE DISCHARGE PERFORMANCE BY EDC/VC PLANTS

Relief valve discharge performance for EDC/VC plants was studied separately from PVC plants. The following formats were selected to express relief valve discharge performance by EDC/VC plants:

- number of discharges
- number of discharges/MM lbs of VC production
- lbs of VC discharged
- lbs of VC discharged/MM lbs of VC production

As in the case of PVC plants, relief valve discharge data from the two data sources described in Section 2 were studied.

3.2.1 Vinyl Institute Data Summaries

Table 3-6 presents a summary of the Vinyl Institute data for relief valve discharge performance by EDC/VC plants. Performance by the VI-member EDC/VC plants is summarized in each of the four selected formats for three 12-month periods between 8/81 and 7/83.

3.2.2 Regional Compliance Data Summaries

Summaries of regional compliance data are given in Tables 3-7 through 3-10 for each of the selected formats. Regional compliance data are summarized in each of the tables for 12-month periods between 1978 and 1983, where ten-day reports are available.

TABLE 3-1. SUMMARY OF VINYL INSTITUTE DATA FOR PVC PLANTS

Plant Code	Number of Discharges/100 Batches 8/81-7/82	2/82-1/83	8/82-7/82	Number of Discharges 8/81-7/82	2/82-1/83	8/82-7/83	Lbs Discharged/MM Lbs PVC 8/81-7/82	2/82-1/83	8/82-7/83	Lbs Discharged 8/81-7/82	2/82-1/83	8/82-7/83
Suspension Reactor Discharges												
S-1	0.000625	0	Plant Down	1	0	Plant Down	28.0	0	Plant Down	2,350	0	Plant Down
S-2	0.0083	0.033	0.025	1	3	2	0.4	4.7	4.3	146	1,530	1,384
S-3*	0.032	0.032	0.025	1	1	1	2.3	2.3	5.5	326	326	1,009
S-4	0.0042	0.0042	0	1	1	0	0.025	0.025	0	4	4	0
S-5	0	0	0	0	0	0	0	0	0	0	0	0
S-6	0.00017	0.00017	0.00025	1	1	1	0.02	0.02	0.2	2	2	11
S-7	0.0083	0	0	1	0	0	142	0	0	12.8	0	0
S-8	0	0	0	0	0	0	0	0	0	0	0	0
S-9*	0.018	0	0.012	1	0	1	0.68	0	0.43	100	0	100
S-10	0	0	0	0	0	0	0	0	0	0	0	0
S-11	0	0	0.0109	0	0	3	0	0	13.7	0	0	1,000
S-12	0	0	0	0	0	0	0	0	0	0	0	0
S-13	0.067	0.101	0.059	7	10	6	109	277	187	14,175	35,852	24,361
S-14	0.033	0.033	0	1	1	0	14.6	14.6	0	2,000	2,000	0
S-15	0	0	0	0	0	0	0	0	0	0	0	0
S-16*	0.0083	0.017	0.034	1	2	4	0.66	43	54	155	8,718	10,818
S-17	0.017	0	0	3	0	0	86	0	0	21,000	0	0
Dispersion Reactor Discharges												
D-1	0	0	0	0	0	0	0	0	0	0	0	0
D-2*	0	0	0	0	0	0	0	0	0	0	0	0
D-3*	0	0	0	0	0	0	0	0	0	0	0	0
D-4	0	0	0	0	0	0	0	0	0	0	0	0
D-5	0.0225	0.035	0.035	1	1	1	13.2	153	153	585	3,830	3,830
D-6	0	0	0	0	0	0	0	0	0	0	0	0
Latex Reactor Discharges												
L-1	0	0	0	0	0	0	0	0	0	0	0	0
L-2	0	0	0	0	0	0	0	0	0	0	0	0
L-3	0	0	0.033	0	0	1	0	0	0.16	0	0	4
Bulk Reactor Discharges												
M-1*	0	0	0.03	0	0	1	0	0	30.7	0	0	1,192
M-2	0.125	0.033	0	2	1	0	405	158	0	14,940	9,090	0
M-3	0.116	0.052	0.125	8	3	8	336	82	267	26,940	5,555	19,665
Nonreactor Discharges												
N-1	0.225	0.117	0.0833	12	7	6	2.5	1.0	1.4	1,150	550	400
N-2*	0.025	0.025	0.0083	2	2	1	10	7.9	0.0025	1,391	1,188	0.4
N-3	0.168	0.275	Plant Down	2	1	Plant Down	1.1	3.6	Plant Down	87	77	Plant Down
N-4	0.10	0.0017	0	5	1	0	2.7	0.17	5.6	527	57	0
N-5*	0	0	0	0	0	0	0	0	0	0	0	0
N-6	0.005	0	0	1	1	1	3.5	9.6	9.6	511	0	0

TABLE 3-1. (Continued)

Plant Code	Number of Discharges/100 Batches 8/81-7/82	2/82-1/83	8/82-7/82	Number of Discharges 8/81-7/82	2/82-1/83	8/82-7/83	Lbs Discharged/MM Lbs PVC 8/81-7/82	2/82-1/83	8/82-7/83	Lbs Discharged 8/81-7/82	2/82-1/83	8/82-7/83
N-7	0	0	0	0	0	0	0	0	0	0	0	0
N-8	0.0092	0.0092	0	1	1	0	8.5	8.5	0	1,200	1,200	0
N-9	0.0058	0.0083	0.0083	1	1	1	0.1	0.0083	0.0083	27	2	2
N-10	0.126	0.054	0.0433	2	1	1	2.7	0.26	0.23	341	41	42
N-11*	0.014	0.014	0	1	1	0	0.79	0.79	0	100	100	0
N-12	0.025	0.025	0	1	1	0	3.0	3.0	0	605	605	0
N-13	0	0	0	0	0	0	0	0	0	0	0	0
N-14	0	0	0	0	0	0	0	0	0	0	0	0
N-15	0	0	0.0056	0	0	1	0	0	0.064	0	0	10
N-16	0.020	0.020	0	1	1	0	17	17	0	1,000	1,000	0
N-17	0	0	0	0	0	0	0	0	0	0	0	0
N-18	0	0.017	0.017	0	1	1	0	9.6	9.6	0	810	810
N-19	0.0067	0.0108	0.0158	1	2	3	2.6	2.3	2.7	378	408	482

*Plants visited.

TABLE 3-2. SUMMARY OF REGIONAL COMPLIANCE DATA FOR PVC PLANTS
(Number of Discharges/100 Batches)

Plant Code	2/78-1/79	8/78-7/79	2/79-1/80	8/79-7/80	2/80-1/81	8/80-7/81	2/81-1/82	8/81-7/82	2/82-1/83	8/82-7/83
Suspension Reactor Discharges										
R-1	0.04	0.059	0.039	0.043	0.024	0	0	0	0	0
R-2	0.017	0.016	0	0	0	0	0	0.031	0.031	0
R-3	0.011	0.011	0.022	0.059	0.079	0.026	0	0.011	0.024	0.01
R-4	(Plant start up 10/79)				0	0	0	0	0	0 0
R-5	0.02	0.02	0.058	0.062	0.013	0.084	0.070	0.011	0.024	0.02
R-6[a]	0.016	0.026	0.046	0.039	0.019	0.019	0.013	0.0083	0.017	0.032
R-7[a]	0	0	0	0	0	0	0.021	0.018	0	0.012
R-8[a]	0.01	ID	ID	ID	ID	ID	0	0	0	0.025
R-9[a]	0	0	0.032	0.036	0	0	0	0	0	0.01
R-10	0.015	0.044	0.043	0.055	0.062	0.027	0.036	0.028	0.020	ND
R-11	0.0083	0	0	0	0.020	0.020	0.020	0.021	0	ND
R-12	0	0	0	0	0	0	0	0	0	0
R-13	0.053	0.059	0.051	0.014	0.008	0	0	0	0	0
R-14	0.013	ID	ID	ID	ID	ID	ID	ID	0.018	0.016
R-15	0.013	ID	ID	ID	0	0.04	0.056	0.026	0.0091	0
R-17	0.010	ID	ID	ID	0.012	0.012	0.012	0.013	0.014	0.012
R-18	0.0078	0.0077	0.0075	0.042	0.042	0.005	0.005	0.006	0.015	0.0066
R-19	0.32	0.21	0.064	0.094	0.12	0.080	0.11	0.085	0.015	ND
Dispersion Reactor Discharges										
R-11	0.027	0.022	0.013	0.0095	0.016	0.005	0	0	0	ND
R-13	0.014	0.014	0.014	0.030	0.033	0	0	0	0	0
R-18	0	0	0	0	0.022	0.022	0	0	0	0
R-19	0.19	0.16	0.054	0	0	0.033	0.034	0	0.039	ND
R-8[a]	0.028	0.028	0	0	0	0.20	0.20	0	0	0
R-6[a]	0	0	0	0	0	0	0	0	0	0
Latex Reactor Discharges										
R-11	0.067	0	0	0	0	0	0	0	0	0
Bulk Reactor Discharges										
R-8[a]	0	ID	ID	ID	ID	ID	0	0.041	0.041	0.030
R-20	0.18	0.077	0.076	0.083	0.030	0.077	0.078	ND	ND	ND
R-21[a]	0	0	0	0	0	0.041	0.042	0	0	0
R-22	0.052	0.12	ID	ID	ID	ID	ID	ID	0.051	0.094

TABLE 3-2. (Continued)

Plant Code	2/78-1/79	8/78-7/79	2/79-1/80	8/79-7/80	2/80-1/81	8/80-7/81	2/81-1/82	8/81-7/82	2/82-1/83	8/82-7/83
Nonreactor Discharges										
R-1	0	0	0.019	0.021	0	0	0	0	0	0
R-2	0	0.016	0.016	0	0	0	0.020	0.062	0.031	0
R-3	0.011	0.011	0.011	0.012	0.053	0.034	0.013	0.022	0.016	0.007
R-4	(Plant start up 10/79)			0.35	0.68	0.57	0.21	0.12	0.054	0
R-5	0.080	0.059	0.078	0.11	0.17	0.16	0.070	0.055	0.074	0.030
R-6[a]	0	0	0	0	0	0	0	0.0075	0.0075	0
R-7[a]	0	0	0	0	0	0.021	0.021	0	0	0
R-8[a]	0.012	ID	ID	ID	ID	ID	0	0	0.012	0.0097
R-9[a]	0	0	0	0	0	0	0	0	0	0
R-10	0	0	0.007	0.008	0	0.009	0.018	0.009	0	ND
R-11	0.014	0.016	0.019	0.018	0.013	0.013	0.0082	0.003	0.003	0.003
R-12	0	~0.013	~0.013	0	0	0	0	0	0	0
R-13	0.036	0	0.004	0.024	0.021	0	0	0.0042	0.0042	0
R-140	ID	ID	ID	ID	ID	ID	ID	0	0	
R-15	0	ID	ID	ID	0	0	0	0	0	0
R-17	0.039	ID	ID	ID	ID	ID	0	0	0	0
R-18	0.026	0.019	0.009	0.007	0.004	0.004	0.012	0.009	0.018	0.005
R-19	0.079	0.047	0.008	0	0	0.028	0.029	0	0	0
R-20	0	0	0	0	0	0	ND	ND	ND	ND
R-21[a]	0	0	0	0	0	0	0	0	0	0
R-22	0.010	ID	ID	ID	ID	ID	ID	ID	0.017	0

ND = No Data; neither 10-day reports nor summaries of 10-day reports available.

ID = Incomplete Data; 10-day report not available for all discharges.

[a]Plants visited.

TABLE 3-3. SUMMARY OF REGIONAL COMPLIANCE DATA FOR PVC PLANTS
(Number of Discharges)

Plant Code	2/78-1/79	8/78-7/79	2/79-1/80	8/79-7/80	2/80-1/81	8/80-7/81	2/81-1/82	8/81-7/82	2/82-1/83	8/82-7/83
Suspension Reactor Discharges										
R-1	2	3	2	2	1	0	0	0	0	0
R-2	1	0	0	0	0	0	0	1	1	0
R-3	1	1	2	5	6	3	0	1	2	1
R-4		(Plant startup 10/79)		0	0	0	0	0	0	0
R-5	1	1	3	4	1	7	7	1	2	1
R-6[a]	3	5	9	7	3	3	2	1	2	4
R-7[a]	0	0	0	0	0	0	1	1	0	1
R-8[a]	1	ID	ID	ID	ID	ID	0	0	0	1
R-9[a]	0	0	2	2	0	0	0	0	0	1
R-10	2	6	6	7	7	3	4	3	2	ND
R-11	1	0	0	0	2	2	2	2	0	ND
R-12	0	0	0	0	0	0	0	0	0	0
R-13	8	9	8	2	1	0	0	0	0	0
R-14	1	ID	ID	ID	ID	ID	ID	ID	1	1
R-15	2	ID	ID	ID	0	5	7	3	1	0
R-17	1	ID	ID	ID	1	1	1	1	1	1
R-18	2	2	2	10	9	1	1	1	2	1
R-19	29	19	6	8	9	6	8	6	1	ND
Dispersion Reactor Discharges										
R-11	6	5	3	2	3	1	0	0	ND	ND
R-13	1	1	1	2	2	0	0	0	0	0
R-18	0	0	0	0	1	1	0	0	0	0
R-19	7	6	2	0	0	1	1	0	1	ND
R-8[a]	1	1	0	0	0	6	6	0	0	0
R-6[a]	0	0	0	0	0	0	0	0	0	0
Latex Reactor Discharges										
R-11	1	0	0	0	0	0	0	0	0	0
Bulk Reactor Discharges										
R-8[a]	0	ID	ID	ID	ID	ID	0	1	1	1
R-20	14	6	6	6	2	5	5	ND	ND	ND
R-21[a]	0	0	0	0	0	1	1	0	0	0
R-22	5	ID	ID	ID	ID	ID	ID	ID	3	6

Table 3-3. (Continued)

Plant Code	2/78-1/79	8/78-7/79	2/79-1/80	8/79-7/80	2/80-1/81	8/80-7/81	2/81-1/82	8/81-7/82	2/82-1/83	8/82-7/83
Nonreactor Discharges										
R-1	0	0	1	1	0	0	0	0	0	0
R-2	0	1	1	0	0	0	1	2	1	0
R-3	1	1	1	1	4	4	2	3	2	1
R-4	(Plant Startup 10/79)			11	23	19	7	2	1	0
R-5	4	3	4	7	13	15	7	5	6	3
R-6[a]	0	0	0	0	0	0	0	1	1	0
R-7[a]	0	0	0	0	0	1	1	0	0	0
R-8[a]	2	ID	ID	ID	ID	ID	0	0	1	1
R-9[a]	0	0	0	0	0	0	0	0	0	0
R-10	0	0	1	1	0	1	2	1	0	ND
R-11	5	6	7	6	4	4	3	1	1	0
R-12	0	1	1	0	0	0	0	0	0	0
R-13	8	0	1	5	4	0	1	1	0	1
R-14	0	ID	ID	ID	ID	ID	ID	ID	0	0
R-15	0	ID	ID	ID	0	0	0	0	0	3
R-17	5	ID	ID	ID	ID	ID	0	0	0	0
R-18	8	6	3	2	1	1	3	2	3	1
R-19	10	6	1	0	0	3	3	0	0	0
R-20	0	0	0	0	0	0	ND	ND	ND	ND
R-21	0	0	0	0	0	0	0	0	0	0
R-22	1	ID	ID	ID	ID	ID	ID	ID	1	0
Solution Process Discharges										
R-23	1	2	2	1	0	0	0	0	0	0

ND = No Data; Neither 10-day reports nor summaries of 10-day reports available.
ID = Incomplete Data; 10-day reports not available for all discharges.
[a]Plants visited.

TABLE 3-4. SUMMARY OF REGIONAL COMPLIANCE DATA FOR PVC PLANTS
(Lbs Discharged/MM Lbs PVC)

Plant Code	Resin Type(s) Produced[a]	1978	1979	1980	1981	1982	1983[c]
R-1	S	470	400	67	0	0	0
R-2	S	46	1	0	1	19	ND
R-3	S	10	26	150	1	28	ID
R-4	S	(Startup 10/79)	0	31	14	1	ND
R-5	S	19	6	13	6	1	ID
R-6[b]	S,D	18	120	23	11	41	10
R-7[b]	S	0	0	0	4	0	1
R-8[b]	S,D,B	105	56	56	200	5	11
R-9[b]	S	0	0	5	0	0	1
R-10	S	28	27	85	106	47[c]	ND
R-11	S,D,L	170	45	21	100	2[c]	ND
R-12	S	0	1	0	0	0[c]	ID
R-13	S,D	490	150	210	4	0[c]	ND
R-14	S,D	1[c]	23	9	1	1	1
R-15	S	38	25	0	380	12	0
R-16	S	ND	6	276	74	0	0
R-17	S	14[c]	77	15	5	0	38
R-18	S,D	35	11	340	4	52	ND
R-19	S,D	520	160	290	90	140	ND
R-20	B	16	21	34	100	ND	ND
R-21	B	0	0	0	1	0	0
R-22	B	100	340	205	300	140	150
R-23	So	27	80	0	0	0	0

ND = No data; 10-day reports not available.
ID = Incomplete data; 10-day reports not available for all discharges.

[a]Resin type code: S = suspension; D = dispersion; L = latex; B = bulk; So = solution.

[b]Plants visited.

[c]Data may be incomplete.

TABLE 3-5. SUMMARY OF REGIONAL COMPLIANCE DATA FOR PVC PLANTS
(Lbs Discharged)

Plant Code	Resin Types Produced[a]	1978	1979	1980	1981	1982	1983[c]
R-1	S	80,000	71,500	10,000	0	0	0
R-2	S	10,249	120	0	167	2,605	ND
R-3	S	3,000	7,760	37,934	484	12,546	19
R-4	S	(Startup 10/79)	0	5,030	2,170	41	ND
R-5	S	4,297	1,450	4,350	2,150	650	400
R-6[b]	S,D	6,000	41,740	5,510	2,550	8,818	2,100
R-7[b]	S	0	0	0	600	0	100
R-8[b]	S,D,B	13,710	7,331	6,164	48,865	1,188	2,393
R-9[b]	S	0	0	1,213	0	0	100
R-10	S	2,937	2,891	7,658	9,515	3,784	ND
R-11	S,D,L	44,860	11,664	4,553	21,860	596	ND
R-12	S	0	60	0	0	0	0
R-13	S,D	84,144	25,506	30,161	511	0	ND
R-14	S,D	25	1,640	511	81	2	11
R-15	S	1,925	1,250	0	15,315	412	0
R-16	S	ND	366	13,809	3,718	0	0
R-17	S	1,840	10,345	1,724	585	0	3,830
R-18	S,D	6,356	1,989	51,705	552	4,153	ND
R-19	S,D	77,500	25,600	37,300	11,700	16,000	ND
R-20	B	2,690	3,700	4,700	13,100	ND	ND
R-21[b]	B	0	0	0	105	0	0
R-22	B	15,405	53,800	28,677	39,097	10,055	10,880
R-23	So	4,586	12,961	0	0	0	0

ND = No Data; 10-day reports not available.

[a]Resin type code: S = suspension; D = dispersion; L = latex; B = bulk; So = solution.

[b]Plants visited.

[c]Data may be incomplete.

TABLE 3-6. SUMMARY OF VINYL INSTITUTE DATA FOR EDC/VC PLANTS

Plant Code	Number of Discharges/MM Lbs of VC Production			Number of Discharges			Lbs Discharged/MM Lbs VC			Lbs Discharged		
	8/81-7/82	2/82-1/83	8/82-7/83	8/81-7/83	2/82-1/83	8/82-7/83	8/81-7/82	2/82-1/83	8/82-7/83	8/81-7/82	2/82-1/83	8/82-7/83
E-1	0.0085	0.0085	0.028	1	1	5	0.6	0.6	51	71	71	12,659
E-2	0.0042	0.013	0.018	1	5	7	0.2	22	30	54	10,434	14,264
E-3	0.0086	0.0087	0.0067	5	6	5	25	26	8	15,905	16,203	5,585
E-4	0	0	0.0025	0	0	3	0	0	4	0	0	4,351
E-5	0.0012	0.0012	0	1	1	0	0.1	0.1	0	80	80	0
E-6	0.020	0.0082	0.0064	4	4	3	11	2.4	3	2,049	1,113	1,360
E-7	0.016	0.019	0.020	3	3	3	17	4.5	7	3,805	640	972
E-8	0.0017	0.0017	0	1	1	0	2	2	0	1,150	1,150	0
E-9	0.0075	0.0083	0.0067	4	5	5	1	17	16	506	12,540	12,214
E-10	0.0025	0.0083	0	2	1	0	140	52	0	89,798	43,209	0

TABLE 3-7. SUMMARY OF REGIONAL COMPLIANCE DATA FOR EDC/VC PLANTS
(Number of Discharges/MM Lbs of VC Production)

Plant Code	2/78-1/79	8/78-7/79	2/79-1/80	8/79-7/80	2/80-1/81	8/80-7/81	2/81-1/82	8/81-7/82	2/82-1/83	8/82-7/83
RE-1	0.0090	0.0055	0.0032	0	0.0025	0.0068	0.0061	0.0016	0	ND
RE-2	0	0	0	0.0016	0.0033	0.0036	0.002	0.0019	0.0067	ND
RE-3								(Plant startup 11/82)		0.012
RE-4	0	0.018	0.018	0.025	0.027	0.0033	ND	ND	ND	ND
RE-5	0	0	0.0015	0.0033	0.0054	0.0039	0.0087	0.025	0.0082	0.0064
RE-6	0.0038	0.011	0.018	0.015	0.0083	0.018	0.020	0.016	ND	ND
RE-7	0	0	0	0	0	0	0.025	0.042	0.026	0.010
RE-8	0.0032	0.0031	0.0031	0.0016	0	0	0	0.0017	0.0017	0
RE-9	0.0057	0.0028	0	0	0	0.031	0.028	0.0081	0.0044	ND
RE-10	0.0040	0.0039	0.0038	0.0027	0	0.0016	0.0018	0.0012	0.0012	0
RE-11	0.0045	0.0053	0.0034	0.0009	0.0020	0.0033	0.0012	ND	ND	ND
RE-12			(Plant startup late 1980)			0.0031	0.0030	0.0031	0	0.0016
RE-13	ND	ND	0.0011	0.0063	0.0087	0.0041	0.0076	0.016	0.0097	0

ND = No Data; 10-day reports not available.

TABLE 3-8. SUMMARY OF REGIONAL COMPLIANCE DATA FOR EDC/VC PLANTS
(Number of Discharges)

Plant Code	2/78-1/79	8/78-7/79	2/79-1/80	8/79-7/80	2/80-1/81	8/80-7/81	2/81-1/82	8/81-7/82	2/82-1/83	8/82-7/83
RE-1	8	5	3	0	2	5	4	1	0	ND
RE-2	0	0	0	1	2	2	1	1	4	ND
RE-3							(Plant startup 11/82)			4
RE-4	0	5	5	7	8	1	ND	ND	ND	ND
RE-5	0	0	1	2	3	2	4	5	4	3
RE-6	1	3	5	4	2	4	4	3	ND	ND
RE-7	0	0	0	0	0	0	5	8	5	2
RE-8	2	2	2	1	0	0	0	1	1	0
RE-9	2	1	0	0	0	15	17	5	3	ND
RE-10	3	3	3	2	0	1	1	1	1	0
RE-11	5	6	4	1	2	3	1	ND	ND	ND
RE-12				(Plant startup late 1980)		2	2	2	0	1
RE-13	ND	ND	1	5	7	3	5	10	6	0

ND = No Data; 10-day reports not available.

TABLE 3-9. SUMMARY OF REGIONAL COMPLIANCE DATA FOR EDC/VC PLANTS (Lbs Discharged/MM Lbs of VC Production)

Plant Code	1978	1979	1980	1981	1982	1983[a]
RE-1	1	3	2	5	0	0
RE-2	0	0	1	1	20	0
RE-3			(Plant start up 11/82)		1	16
RE-4	4	24	10	0	ND	ND
RE-5	0	2	8	6	2	3
RE-6	0	2	14	2	58	ND
RE-7	0	0	0	1	70	0
RE-8	1	9	0	0	2	ND
RE-9	1	0	0	21	23	ND
RE-10	10	23	0	1	1	0
RE-11	21	5	1	1	ND	ND
RE-12	1	(Plant start up late 1980)		5	0	1
RE-13	ND	ND	1	71	70	ND

ND = No Data; 10-day reports not available.

[a]Data may be incomplete.

TABLE 3-10. SUMMARY OF REGIONAL COMPLIANCE DATA FOR EDC/VC PLANTS
(Lbs Discharged)

Plant Code	1978	1979	1980	1981	1982	1983[a]
RE-1	638	2,638	1,967	2,961	0	0
RE-2	0	0	485	9	12,240	0
RE-3			(Plant start up 11/82)		40	5,160
RE-4	1,170	6,870	3,220	0	ND	ND
RE-5	0	1,530	4,490	2,740	1,110	1,230
RE-6	0	660	3,300	320	11,000	ND
RE-7	0	0	0	108	13,270	0
RE-8	24	6,000	0	0	1,150	ND
RE-9	109	0	0	12,700	15,900	ND
RE-10	7,500	17,700	0	1	80	0
RE-11	23,200	6,280	450	1,030	ND	ND
RE-12	(Plant start up late 1980)		1,670	5,123	0	84
RE-13	ND	ND	565	46,722	43,291	ND

ND = No Data; 10-day reports not available.

[a]Data may be incomplete.

4.0 CONTROL OF RELIEF VALVE DISCHARGES

This section documents the experience and information about control of relief valve discharges obtained in the various phases of the review study for the VC standard. The original standards support document (EPA-450/2-75-009) and the review study (EPA-450/3-82-003) identified some methods employed to prevent relief valve discharges. The 10-day compliance reports obtained from EPA Regional Offices also provided information on preventive measures. Finally, information obtained during five plant visits is included in Tables 4-1 and 4-2. Reports documenting these visits are contained in Docket Number A-81-21.

A variety of methods are used by PVC and EDC/VC producers to prevent relief valve discharges. In general, these methods involved implementation of equipment modifications, process modifications, or operational practices. The exact combination of modifications and operational practices implemented varies plant by plant. Effectiveness of individual measures intended to prevent relief valve discharges is difficult to discern and consequently, emission reductions can not be assigned to individual control measures. Because no specific combination of RVD control measures were required by EPA, individual producers have implemented the combination of control measures they judged to be needed to comply with the standard.

4.1 CONTROL MEASURES AT PVC PLANTS

Descriptions of the control measures used by various PVC plants to prevent relief valve discharges follow.

Shortstop Systems

A shortstop system can be used to stop the polymerization reaction when upset conditions develop. A shortstop system injects a chemical agent into the reactor which terminates the reaction by inhibiting the action of the initiator. The system is either manual, automated, or a combination of the

TABLE 4-1. RVD CONTROLS OBSERVED AT PVC PLANTS

Control Measure	Number of Plants (of 5 Total)
Hardware	
Computer Control	3
Backup Power	4
Supplemental Reactor Cooling	4
Gasholder	3
Shortstop System	4
Redundant Instrumentation	4
Preventive Maintenance	
Rupture Disc Maintenance	4
Relief Valve Maintenance	4
Other (Specific to RVD Prevention)	2*
Operating Training	
Initial Training - Classroom	4
- On-The-Job	5
- Formal Progress Review	3*
Continuing Training - Routine Safety Meetings	5
- Other	2
Review of RVD (or "Near Miss") Incident With Operators(s)	5

*It is unknown whether the other plants that were visited have implemented these measures.

TABLE 4-2. RELIEF VALVE DISCHARGE CONTROLS AT FIVE PVC PLANTS

Control Measure	Plant Code				
	R-6	R-8	R-9	R-7	R-25
Shortstop System					
- automatic/computer activated	No	No	Yes	No	No
- automatic/operator activated	Yes - large suspension reactors only	Yes - suspension	Yes	Yes	No
- portable/manual	Yes - small reactors	Yes	No	No	No
- backup	Unknown	Yes - portable	Unknown	Yes - Manual activation	No
Redundant Instrumentation					
- reactor process sensors	No	Yes	Yes	Yes	Yes
- reactor charging operations	Yes - large suspension reactors only	Yes	Yes	Yes	Yes
- estimated degree of redundancy	Low	High	High	High	Very High
Computer Control					
- redundant (computer) backup	No	Yes	Yes	Yes	No
- manual (panel) backup	No	Yes - large suspension reactors only	No	Yes	No
- operations controlled	None	All	All	Reactor charging, polymerization and blowdown sequence	None
Backup Power					
- agitators/support equipment	Yes	Yes	No	No	Yes
- computer/instruments	No	Yes	No	Yes	Unknown
- pumps/compressors/seal oil circulation	Yes	Yes	No	Yes	Yes
- refrigeration	No	No	No	Yes	Unknown

TABLE 4-2. (Continued)

Control Measure	R-6	R-8	R-9	R-7	R-25
	Plant Code				
Supplemental Reactor Cooling					
- standby cooling water pump	Unknown	Unknown	Unknown	Unknown	Yes
- excess refrigeration capacity	No	No	Yes	Yes	No
- relux condenser	Yes - large suspension reactors only	Yes - bulk reactors only	Yes	Yes - large reactors only	Yes
Gasholder					
- VCM recovery/incinerator surge	Yes	No	Yes	Yes	No
- non-reactor RVDs vented	No	No	Yes	Yes	No
- reactor RVDs vented	No	No	No	No	No
Operator Training					
- initial training (new operators)					
- classroom	Yes - 13 1-hr sessions	Yes 3 months	Yes	No	Yes - 1 week
- on-the-job	Yes - 21 days with skilled operator	Yes total	Yes	Yes - 6 to 12 months	Yes - 30 days with experience operator
- progress review	Unknown	Written; performance	Unknown	Certification	Written; oral
- continuing (qualified operators)					
- routine safety meetings	Yes - 1hr/month	Yes - 2 hr/month	Yes - monthly	Yes	Yes - monthly
- other	None	Emergency response training; shift assignments	shift briefings	None	None
- RVD incident review	Yes	Yes	Yes	Yes	Yes
Preventive Maintenance					
- rupture disc	Replaced annually	Replaced annually or sooner, if needed	Replaced annually	Replaced annually	Replaced as needed
- relief valve	Tested before installation and annually	Shop tested every two years		Tested annually	Inspected annually
- other					
backup power generator	Yes	Yes	Unknown	Unknown	Unknown
shortstop system	Yes	Unknown	Unknown	Unknown	Unknown

two. The success of a shortstop system at preventing relief valve discharges is dependent on several factors including (1) having sufficient agitation within the reactor for complete dispersion of the shortstop throughout the reactor contents, (2) the charge manifold (i.e., the manifold used to charge ingredients to the reactor) being clear, and (3) the timing of personnel or control systems in initiating the shortstop.

Two primary variations of automated shortstop systems exist. Some computer-controlled plants have built-in programs that recognize the upset condition by monitoring operating parameters and that automatically inject the shortstop agent when needed. Other computer-controlled plants monitor operating parameters and automatically alert operators when shortstop is needed. Actual activation of shortstop injection, however, is performed by the operator.

At some older plants, only manual shortstop systems are available. Operators are responsible for deciding when shortstop is required and for manually injecting the shortstop agent. Manual shortstop systems are also maintained as backup to automatic systems in some plants. Both manual and automatic shortstop systems have been found to be capable of effectively preventing relief valve discharges.

Redundant Instrumentation

The degree of instrumentation can be important in preventing relief valve discharges and varies greatly among plants. For example, instrumentation monitoring reactor operating parameters (e.g., pressure, temperature) warns operators of an emergency condition so that immediate action can be taken. If the primary sensor fails, an emergency condition may go undetected and a relief valve discharge may result if a secondary sensor is not present.

Other instruments, in addition to those monitoring actual reaction conditions, contribute to the prevention of an upset condition. For example, overcharging a reactor is a common cause of relief valve discharges. A metering system for charging exact amounts of liquid VC and other ingredients in combination with accurate weigh tanks can prevent overcharging and the subsequent hydroful condition. Dual metering in series for both VC and water is also used by some plants to prevent overcharging. Sophisticated metering systems are not necessarily required. One plant has successfully implemented a simple manual procedure to physically measure the liquid level in the reactors as a check on the charge meter readings.

Computer Control

Many of the newer PVC plants have included computer control as part of the original equipment and process design. In addition, several older plants have added computers, or are planning to add computers, to control their production operations. The primary use of these computers is in operating and monitoring the batch polymerization process. In most cases, the computer performs and monitors all reactor charging operations (including the proper sequence of valve opening and closing and pump operation) and monitors reaction conditions. The reactor blowdown sequence is also performed by the computer in most cases.

Computer control at the various plants differs in the degree of "decision making." As discussed previously, some computers not only alert operators to emergency reactor conditions but also automatically inject shortstop. The point at which shortstop is injected depends on programmed limits for key monitored parameters. The selection of these limits reflects a plant's judgment on the appropriate margin of safety. Other computers alert operators of emergency conditions but allow operators to make the final decision on the appropriate corrective actions.

Another factor that affects the effectiveness of computer control is the quality of the programming in the system. Although subjective, several plants have expressed varying opinions on degrees of confidence in this aspect of the system. As a result, at least one plant continually searches for and makes improvements in their system software.

Backup Power

Auxiliary sources of power are used by some plants to maintain agitation, cooling, and instrumentation in the event of losing the main power source to a plant. No auxiliary power systems currently found in PVC plants are designed to operate the entire plant; rather, power is usually only available to safely shut down the plant by allowing those polymerization reactions in progress to be terminated or finished. Most plants have dual power lines into the plant to provide primary power. The dual lines keep power constant and prevent sudden surges and dips in power or a complete loss of power. Emergency back-up power is usually supplied by diesel-driven generators. DC batteries may be available to operate instruments and computers.

Backup power generation capacity varies from plant to plant. Typically, sufficient backup power generation capacity is available to maintain agitation in reactors until shortstop can be effectively dispersed. However, shortstop systems used at some plants do not require agitation for effective dispersement, and these plants may have no backup power generators.

Supplemental Reactor Cooling

In the event that reaction temperature exceeds normal conditions, some plants have available methods for providing supplemental reactor cooling. For example, additional cooling water may be supplied by a standby cooling water pump. In some cases, plants using refrigerated cooling water have excess refrigeration capacity to provide additional chilled water if needed. Other sources maintain a reserve capacity of chilled water for use in the event of cooling tower or refrigeration system failure. Reflux condensers are operated on some reactors. Although the primary purpose of the reflux condensers is to maintain constant reactor conditions and to improve product quality, they also provide an additional means for cooling reactor contents.

Gasholders

A gasholder is a cylindrical, variable-volume vessel. The most common type of gasholder is a vessel with a floating roof with either a water seal or a double inner synthetic seal that expands to accommodate the influx of gas. The operating principle of a gasholder is based on piston displacement. A free moving piston floats on the confined gas, rising and falling with changes in the volume of stored gas. As gas enters and builds up to the designed operating pressure, the piston rises and floats on the gas.

Gasholders are currently being used at some plants as part of the recovery system to contain and store VC gas collected from various emission sources in the plant. The gases stored can be fed to the recovery system, or the gasholder can serve as a surge vessel feeding the primary control device. (Incinerators must receive a near constant flow and concentration of combustibles for proper operation.)

At present, a few plants are venting small nonreactor relief valve discharges to gasholders. However, no plant has connected a reactor relief valve directly to a gasholder or uses a gasholder only for relief valve discharges. Some plants manually relieve reactor pressure to gasholders serving as part of the VC recovery system.

Enhanced Operator Training

A staff of qualified operators able to recognize a potential emergency situation and take appropriate measures to prevent a discharge are a key element in minimizing relief valve discharges. The different levels of the previously described hardware controls help to eliminate common operator errors and aid the operator in detecting potential problems, but the hardware controls including computers do not provide the decision-making capabilities that are only found in experienced operations personnel. The right combination of operator experience and hardware control is an important preventive measure against relief valve discharges.

Operator training programs vary from company to company. Initial training programs range from several weeks to over a month with routine retraining and refresher programs required for all operations. Typically, operators responsible for relief valve discharge incidents or "near misses" are counseled and at some plants displinary actions may be taken. The importance of effective training in preventing relief valve discharges was verified in plant visit discussions. Every plant with a successful relief valve discharge performance record that was visited attributed a large part to their success to the concern of management in preventing relief valve discharges and their commitment toward transmitting this concern through effective training of operators.

Preventive Maintenance

Routine maintenance of relief devices, rupture discs and other hardware associated with relief valve discharge prevention is an effective method of reducing discharges due to premature rupture disc failure and other equipment and instrument failure. Plants generally inspect and/or dismantle and shop test relief valves on a routine basis (i.e., once per year) following installation. Rupture discs are typically replaced on an annual basis. Some plants also replace rupture discs on an "as needed" basis. An example would be when they are subjected to pressures exceeding set tolerances.

Different maintenance programs are practiced by plants for other hardware associated with relief valve discharge prevention. For instance, backup power generators may be started on a regular basis and shortstop systems may be inspected periodically to ensure problem-free operation if needed.

4.2 RVD CONTROLS AT PLANTS VISITED

Five PVC plants that have successfully reduced or eliminated relief valve discharges were visited to find out what relief valve discharge control measures had been implemented. It was found that different combinations of control measures are used at the five plants. As indicated in Table 4-1, each of the control measures described in Section 4.1 have been implemented by at least one of the five plants.

According to plant personnel at each of the five plants, an exact relationship does not exist between specific control measures and prevention of discharges. Further, many of the identified relief valve discharge control measures were implemented primarily for reasons other than relief valve discharge control, with prevention of discharges a secondary benefit. Plant personnel indicated in most instances that the relief valve discharge controls in place would be retained even in the absence of a relief valve discharge standard because of their role in improving the production process and reducing product loss.

Table 4-2 presents a summary of the specific relief valve discharge controls at the five visited plants.

4.3 CONTROL MEASURES AT EDC/VC PLANTS

Information obtained during the review study indicate that many of the same hardware and operational practices associated with prevention of relief valve discharges at PVC plants have been implemented by EDC/VC producers. Specifically, the backup power, supplemental cooling (for product columns), and redundant instrumentation are applicable hardware controls that are available at at least some EDC/VC plants. Enhanced operator training programs are equally important for relief valve discharge prevention at EDC/VC plants.

5.0 CAUSES OF RELIEF VALVE DISCHARGES

A wide variety of causes for relief valve dishcarges are reported by PVC and VC producers. Each relief valve discharge incident has its own set of unique circumstances. Also, discharges often result from a combination of causes. Consequently, it is difficult to classify the causes of individual discharges into distinct categories. However, several general categories of relief valve discharge causes were identified for the purpose of this analysis and are discussed below.

Based on regional compliance data, discussions with EPA Regional Office representatives and plant visits, the following general categories of relief valve discharge causes were identified.

Operator Error. The most frequently reported cause of relief valve discharges is operator error or failure to follow applicable standard operating procedures (SOPs). A number of factors may contribute to operator error-caused discharges. For example, failure by an operator to follow SOPs may be due to inadequate training or failure on the part of management to properly define the appropriate SOP. In other cases, operator negligence is the primary reason for not following the SOP. Some operator-caused discharges are simply due to the inevitable element of human error. A few examples of discharges attributed to operator error are given below.

- A reactor was overcharged with VC resulting in a hydroful condition when the operator failed to close the VC charge valve. Also, the operator failed to set high pressure alarm prior to the reactor charging sequence.
- A reactor overpressured due to erratic reaction kinetics and the operator did not react according to the standard operating procedure for controlling the reaction.

- An operator failed to switch reactor control instruments from manual to automatic control and the reactor overheated and consequently overpressured.
- Identifications of two valves were mislabeled during instrument panel modifications for expansion. An operational error occurred during manual control, causing the recovery system to overpressure.

Premature Releases. Premature releases from relief devices are another frequently reported cause of relief valve discharges. A premature release occurs when a pressure relief device relieves to the atmosphere at a pressure lower than the minimum rated pressure. The most widely used relief devices in PVC and EDC/VC plants are rupture disc/safety relief valve (RD/SRV) assemblies (see Figure 5-1). Usually, premature releases are caused by premature failure of rupture discs. Premature failure of the rupture disc results in a surge of pressure which causes the SRV to lift. Both the size and the duration of this type of discharge are normally small. However, if polymer or some other material prevents the valve from reseating, the discharge may be much larger.

Some premature rupture disc failures are the result of improper installation. Others are the result of exceeding the recommended service of the rupture disc. The recommended service life of a rupture disc is normally one year. Failure to replace rupture discs on an annual basis can result in premature failure. In addition, a rupture disc can be damaged if the operating ratio is exceeded. The operating ratio is the ratio of operating pressure to the stamped burst pressure that the disc can withstand. The operating ratio for most rupture discs is 70 percent. Consequently, a rupture disc rated at 200 psig with a 70 percent operating ratio would likely be damaged at pressures exceeding 140 psig. Once the operating ratio is exceeded, rupture disc manufacturers recommend that the disc be replaced to avoid the possibility of premature failure.

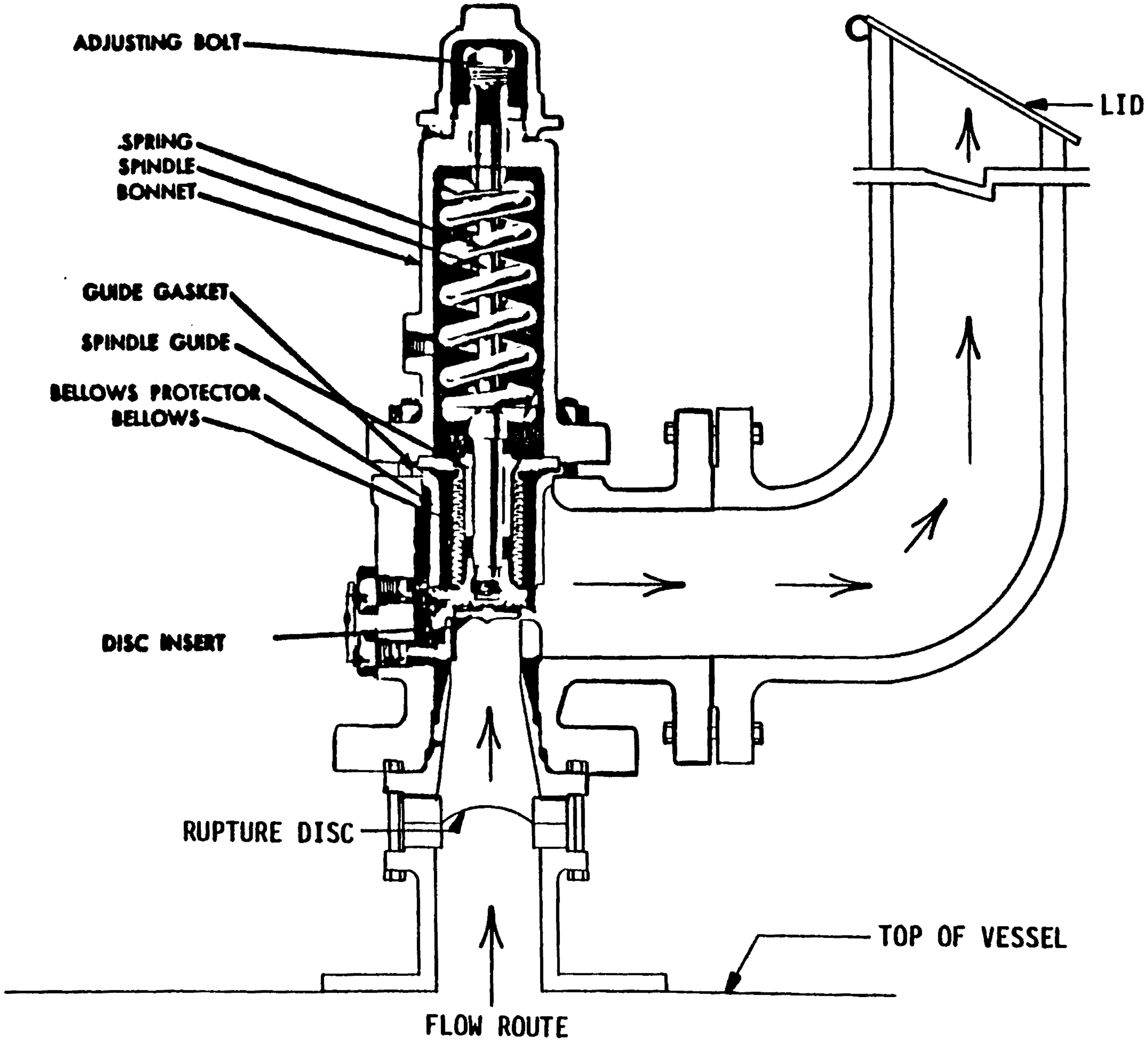

Figure 5-1. Rupture Disc/Safety Relief Valve Assembly

Equipment Failure. Relief valve discharge can occur due to the failure of process equipment. Failure of reactor cooling and agitation equipment are two common causes of relief valve discharges. When the reactor cooling system equipment malfunctions, the reactor contents may heat-up resulting in overpressuring due to thermal expansion. Upon failure of reactor agitation equipment, reactor contents cannot be adequately cooled and the reactor may overpressure. If the shortstop used requires agitation for effective dispersement, it is possible that a relief valve discharge will occur. At EDC/VC plants, loss of cooling system equipment may allow contents of process vessels (i.e. VC) to heat-up resulting in overpressuring due to thermal expansion.

Instrument Malfunction. Another frequently reported cause of relief valve discharges is instrument malfunction. Instrument malfunction includes failure or malfunction of temperature indicators, pressure sensors and transmitters, level indicators and controllers. Instrument malfunction may result in erroneous control of the process or overfilling of tanks and vessels. Instrument malfunction can often be attributed to insufficient or improper maintenance.

Power Failure. A less frequent but nonetheless significant cause of relief valve discharges is power failure. Relief valve discharges resulting from power failure are generally larger (in terms of amount of VC discharged) than discharges from other causes. Once power is lost, reactor cooling and agitation are normally interrupted unless backup power is available. The potential for discharge from multiple reactors exists in the absence of reactor cooling and agitation. However, an established procedure for safe plant shutdown can be effective in preventing relief valve discharges when a power failure occurs and no backup power is available.

6.0 BASIS OF SUMMARY TABLES

6.1 SUMMARIES OF VI DATA

Relief valve discharge data for 19 PVC and 10 EDC/VC plants were supplied by the Vinyl Institute (VI). A summary of the raw data provided by the VI are given in Tables 6-1 and 6-2. Table 6-1 is a summary of PVC data. Table 6-2 is a summary of EDC/VC data. All data were given on a monthly basis for the period 8/81 through 8/83. Months with no discharges are not presented in Tables 6-1 and 6-2.

The data supplied by the VI are summarized on an annual basis for selected formats in Table 3-1 for PVC plants and in Table 3-6 for EDC/VC plants. The formats presented in Table 3-1 are number of discharges per 100 polymerization batches, number of discharges, lbs of VC discharged per MM lbs of PVC production, and lbs of VC discharged. Note that the difference between data in Table 6-1 and Table 3-1 is the period of time, one month versus one year. To calculate the number of discharges per 100 batches for a one year period, the number of discharges per 100 batches were summed for the 12-month period and divided by 12 to estimate the average monthly batch rate. This method assumes that the number of batches produced in months when a discharge occurred are representative of the actual average number of batches per month throughout the year.* Values for numbers of discharges presented in Table 3-1 are simply the sum of discharges shown in Table 6-1 for the respective one-year periods. The lbs of VC discharged per MM lbs of PVC production values presented in Table 3-1 were calculated in the same way as the number of discharges per 100 batches. The monthly lbs of VC discharged per MM lbs of PVC production values were summed for a 12-month period and divided by 12. Again, this method assumes

*This assumption was verified as reasonable with the originators of the data on the basis that releases occur randomly and that the average of a number of randomly selected months is a reasonable approximation of the actual average monthly batch rate.

that monthly production in the months that discharges occurred is representative of the actual monthly average production rate over the year. Pounds of VC discharged values presented in Table 3-1 are the lbs of VC discharged values in Table 6-1 summed for the 12-month period.

Values presented in Table 3-6 for EDC/VC plants were generated the same way as for PVC plants with one exception. For EDC/VC plants, the numbers of discharges per MM lbs VC of production are presented in place of the number of discharges per 100 batches. Number of discharges per MM lb of VC production values were calculated by summing the number of discharges per MM lbs of VC production values in Table 6-2 for the respective 12-month periods and dividing by 12.

6.2 SUMMARIES OF REGIONAL DATA

Summaries of regional data for PVC plants are presented in Tables 3-2 through 3-5. Table 3-3 presents the regional compliance data for PVC plants in the format of number of discharges per one-year period. Values presented in this table are based on the summary of 10-day reports presented in Table 6-3. The number of discharges within each one-year period were summed to obtain the values in Table 3-3. Pounds of VC discharged values in Table 3-5 were developed in the same way, by summing the reported lbs of discharge in Table 6-3 for each one-year period.

The number of discharges per 100 batches presented in Table 3-4 were developed by dividing the annual number of discharges in Table 3-3 by an estimated number of batches for the particular plant and year. Estimating the number of batches was based on data from several sources including trip reports, EPA Regional Office contacts, and the VI. It was possible to estimate typical numbers of batches produced per month per reactor for different resin types and for large and small suspension reactor sizes for the years 1981, 1982, and 1983 using data from the VI. These typical monthly reactor batch rates were multiplied by 12 to approximate typical yearly reactor batch rates for each resin type for 1981, 1982, and 1983. These factors are shown in Table 6-5. To estimate similar yearly reactor batch rates for 1978, 1979, and 1980 the 1982-1983 rates were scaled with the industry capacity utilization rates shown in Table 6-4. Based on the information presented in Table 6-5 and information on the number of reactors at individual plants, the number of batches produced at each plant were estimated for each one-year period. The estimates of the number of annual batches produced at each plant may be sensitive to the plants. For this reason, neither the estimated number of batches for each plant nor the numbers of reactors at each plant are presented here. The number of discharges per 100 batches values presented in Table 3-2 were obtained by dividing the number of discharges presented in Table 3-3 for each time period by the estimated number of batches obtained by the methods outlined above. As a supplement to this approach, it was possible to use data from the Vinyl Institute to make more accurate estimates of the number of batches for some plants.

Regional PVC data are presented in the format of lbs of VC discharged/MM lbs of PVC production in Table 3-4. Estimated values of MM lbs PVC production were required to calculate lbs of VC discharged/MM lbs of PVC production. Annual production for each plant was estimated using published PVC production capacities shown in Table 6-6 and the capacity utilization factors shown in Table 6-4. The lbs of VC discharged values for each year in Table 3-5 were divided by the estimated annual PVC production to obtain the values in Table 3-4.

Summaries of regional compliance data for EDC/VC plants are presented in Tables 3-7 through 3-10. Table 3-8 presents regional compliance data for EDC/VC plants in a format of number of discharges per one-year period. Values presented in the table are based on the summary of 10-day reports given in Table 6-7. The number of discharges within a one-year period were summed to obtain the values in Table 3-8. The lbs of VC discharged values presented in Table 3-10 also were developed from Table 6-7, by summing the reported amount of individual discharges for each one-year period.

Tables 3-7 and 3-9 which summarize relief valve discharge performance by EDC/VC plants in the remaining two formats (i.e., number of discharges/MM lb VC and lbs of discharge per MM lb VC), required the estimation of VC production. Annual VC production of each plant was estimated using Tables 6-8 and 6-4. Table 6-8 presents the published VC production capacities of individual plants. These production capacities were used with capacity utilization factors in Table 6-4 to estimate the annual production at each plant for the years 1978 through 1983. As a supplement to this approach, it was possible to use the actual production data from the Vinyl Institute along with data from other nonproprietary sources to make more accurate production estimates for some plants. Although these data are not listed because they may be considered confidential to the respective plant operators, they were used in producing the summary tables in Section 3.

The number of discharges presented in Table 3-8 were divided by the estimated annual VC production rates for the respective plants to produce the number of discharges per MM lbs of VC production values in Table 3-7. Similarly, the lbs of VC discharged values presented in Table 3-10 were divided by estimated VC production rates to produce the lbs of VC discharged per MM lbs of VC production values in Table 3-9.

TABLE 6-1. VINYL INSTITUTE RAW DATA FOR PVC PLANTS[a]

Plant Code	Month	Number of Discharges Per MM Lbs of PVC Produced	Lbs Discharged Per MM Lbs of PVC Produced	Number of Discharges	Lbs Discharged	Number of Discharges Per 100 Batches	Lbs Discharged Per 100 Batches
Suspension Reactor Discharges							
S-1[b]	8/81	0.095	223.8	1	2,350	0.005	1.250
S-2	4/82	0.032	4.7	1	146	0.1	20.9
	1/83	0.074	51.3	2	1,384	0.3	230.7
S-3	5/82	0.09	27.93	1	326	0.38	123.95
	4/83	0.07	66.41	1	1,009	0.30	298.52
S-4	4/82	0.08	0.3	1	4	0.05	0.2
S-5	No Discharges						
S-6	3/82	0.125	0.25	1	2	0.002	0.004
	6/83	0.197	2.17	1	11	0.003	0.034
S-7	10/81	0.10	1,706.4	1	12.8	0.1	1,621.4
S-8	No Discharges						
S-9	9/81	0.08	8.2	1	100	0.21	21.1
	7/83	0.05	5.2	1	100	0.15	15.6
S-10	No Discharges						
S-11	2/83	0.172	69.1	1	400	0.131	52.2
	8/83	0.316	95.0	2	600	0.251	75.4
S-12	No Discharges						
S-13	8/81	0.16	73.5	2	909	0.19	88.5
	2/82	0.08	245.5	1	3,000	0.11	315.5
	5/82	0.25	690.9	3	8,170	0.32	859.0
	7/82	0.14	300.7	1	2,096	0.18	376.3
	10/82	0.18	1,144.8	2	12,850	0.22	1,435.8
	12/82	0.06	230.0	1	3,680	0.08	290.9
	1/83	0.24	714.2	2	6,056	0.30	916.6
	2/83	0.08	150.4	1	1,775	0.11	189.6
S-14	3/82	0.09	175.0	1	2,000	0.4	743.5
	8/83	0.07	0.8	1	12	0.3	3.5
S-15	No Discharges						
S-16	9/81	0.05	7.9	1	155	0.10	15.1
	8/82	0.06	506.9	1	8,560	0.10	877.9
	10/82	0.05	8.2	1	158	0.10	15.6
	6/83	0.04	11.3	1	300	0.07	22.0
	7/83	0.07	126.0	1	1,800	0.14	244.2
S-17	9/81	0.1	1,028.9	3	21,000	0.2	1,548.7
Dispersion Reactor Discharges							
D-1	No Discharges						
D-2	No Discharges						
D-3	No Discharges						
D-4	No Discharges						
D-5	11/81	0.273	159	1	585	0.27	159
	1/83	0.479	1,836	1	3,830	0.42	1,609
D-6	No Discharges						

TABLE 6-1. (Continued)

Plant Code	Month	Number of Discharges Per MM Lbs of PVC Produced	Lbs Discharged Per MM Lbs of PVC Produced	Number of Discharges	Lbs Discharged	Number of Discharges Per 100 Batches	Lbs Discharged Per 100 Batches
Latex Reactor Discharges							
L-1		No Discharges					
L-2		No Discharges					
L-3	6/83	0.5	1.9	1	4	0.4	1.8
Mass Reactor Discharges							
M-1	6/83	0.3	369.1	1	1,192	0.36	422.7
M-2	12/81	0.5	2,968.0	1	5,850	1.1	6,290.3
	7/82	0.2	1,894.1	1	9,090	0.4	3,969.4
M-3	8/81	0.122	449	1	3,690	0.137	504
	9/81	0.327	1,948	2	11,900	0.387	2,302
	10/81	0.231	686	2	5,950	0.264	785
	12/81	0.143	57	1	400	0.166	66
	1/82	0.168	587	1	3,500	0.198	693
	6/82	0.204	307	1	1,500	0.235	352
	10/82	0.169	616	1	3,655	0.206	754
	11/82	0.142	57	1	400	0.179	72
	3/83	0.357	1,292	2	7,250	0.425	1,539
	4/83	0.413	715	3	5,200	0.515	892
	7/83	0.165	521	1	3,160	0.179	566
Non-Reactor Sources							
N-1	8/81	0.03	3.13	1	100	0.3	25.5
	9/81	0.09	8.86	3	300	0.7	69.8
	10/81	0.02	2.46	1	100	0.2	20.2
	11/81	0.03	3.10	1	100	0.3	25.6
	1/82	0.07	7.08	3	300	0.6	58.6
	3/82	0.02	1.95	1	100	0.2	17.8
	4/82	0.02	2.28	1	100	0.2	19.2
	6/82	0.02	1.00	1	50	0.2	8.4
	10/82	0.02	1.07	1	50	0.2	8.5
	11/82	0.02	2.33	1	100	0.2	19.0
	12/82	0.03	1.41	1	50	0.2	11.6
	1/83	0.02	2.01	1	100	0.2	17.2
	3/83	0.02	8.29	1	500	0.1	70.3
	7/83	0.02	1.74	1	100	0.1	14.9
N-2	12/81	0.13	25.9	1	203	0.1	29.6
	7/82	0.08	94.6	1	1,188	0.2	235.2
	11/82	0.07	0.03	1	0.4	0.1	0.06
N-3[b]	9/81	0.12	1.2	1	10	0.79	7.9
	3/82	0.095	7.3	1	77	0.55	43.3

TABLE 6-1. (Continued)

Plant Code	Month	Number of Discharges Per MM Lbs of PVC Produced	Lbs Discharged Per MM Lbs of PVC Produced	Number of Discharges	Lbs Discharged	Number of Discharges Per 100 Batches	Lbs Discharged Per 100 Batches
N-4	9/81	0.047	0.9	1	20	0.2	4.2
	10/81	0.068	24.3	1	357	0.3	109.2
	11/81	0.058	5.1	1	89	0.3	23.2
	1/82	0.048	0.2	1	4	0.2	0.9
	6/82	0.034	2.0	1	57	0.2	8.8
	8/83	0.030	67.8	1	2,252	0.1	305.2
N-5	No Discharges						
N-6	9/81	0.08	41.9	1	511	0.06	30.6
	1/83	0.10	115.8	1			
N-7	No Discharges						
N-8	4/82	0.085	102.1	1	1,200	0.11	135.9
N-9	9/81	0.05	1.2	1	27	0.07	1.8
	11/82	0.06	0.1	1	2	0.1	0.2
N-10	9/81	0.09	29.7	1	300	0.86	259.0
	2/82	0.08	3.13	1	41	0.65	26.4
	7/83	0.06	2.73	1	42	0.52	21.9
	8/83	0.11	49.5	1	443	0.91	403.0
N-11	7/82	0.095	9.5	1	100	0.17	17.1
N-12	4/82	0.06	36.0	1	605	0.3	152.8
N-13	No Discharges						
N-14	No Discharges						
N-15	4/83	0.08	0.77	1	10	0.067	0.674
N-16	6/82	0.204	204	1	1,000	0.235	235
N-17	No Discharges						
N-18	1/83	0.1	115.8	1	810	0.2	179.2
N-19	1/82	0.08	31.4	1	378	0.08	29.8
	8/82	0.06	12.9	1	213	0.06	12.2
	10/82	0.08	15.2	1	195	0.07	14.3
	2/83	0.06	4.7	1	74	0.06	4.4

[a] Data includes releases from relief valves, rupture discs and manual vents in VC service. Data are for the period 8/81 - 8/83; data for months with no discharges are not included in the table.

[b] Plant production ceased 4/82.

[c] Plant shut down undefinitely on 6/83.

TABLE 6-2. VINYL INSTITUTE RAW DATA FOR EDC/VC PLANTS[a]

Plant Code	Month	Number of Discharges Per MM Lbs of VC Production	Lbs Discharged Per MM Lbs of VC Production	Number of Discharges	Lbs Discharged
E-1	4/82	0.102	7.26	1	71
	2/83	0.253	203.45	3	2,413
	5/83	0.040	410.92	1	10,200
	7/83	0.046	2.13	1	46
E-2	12/81	0.05	2.6	1	54
	8/82	0.09	37.9	3	1,209
	10/82	0.02	209.5	1	8,925
	12/82	0.05	16.0	1	300
	4/83	0.05	99.7	2	3,830
	8/83	0.02	3.6	1	145
E-3	9/81	0.047	0.84	2	35
	2/82	0.022	1.56	1	72
	3/82	0.019	271.10	1	13,878
	4/82	0.015	28.10	1	1,920
	8/82	0.032	5.65	2	354
	9/82	0.016	0.81	1	51
	5/83	0.032	83.82	2	5,181
E-4	4/83	0.02	47.9	2	4,095
	5/83	0.01	2.9	1	256
E-5	6/82	0.014	1.1	1	80
E-6	8/81	0.087	6.7	1	77
	10/81	0.105	104.5	1	993
	6/82	0.052	25.4	2	979
	8/82	0.025	3.3	1	133
	11/82	0.021	0.02	1	1
	5/83	0.031	38.6	1	1,226
	8/83	0.027	0.05	1	2

TABLE 6-2. (Continued)

Plant Code	Month	Number of Discharges Per MM Lbs of VC Production	Lbs Discharged Per MM Lbs of VC Production	Number of Discharges	Lbs Discharged
E-7	12/81	0.053	191.59	1	3,641
	3/82	0.043	2.11	1	49
	7/82	0.096	11.03	1	115
	9/82	0.087	41.26	1	476
	3/83	0.088	33.39	1	380
	7/83	0.072	8.36	1	116
	8/83	0.074	8.76	1	119
E-8[b]	4/82	0.02	23	1	1,150
E-9	8/81	0.02	2.2	1	105
	10/81	0.02	0.02	1	1.3
	2/82	0.02	1.7	1	100
	5/82	0.03	8.7	1	300
	8/82	0.02	61.7	1	3,600
	9/82	0.01	0.6	1	40
	11/82	0.02	129.0	1	8,500
	2/83	0.02	0.8	1	50
	3/83	0.01	0.3	1	24
E-10	12/81	0.02	1,047.1	1	46,589
	6/82	0.01	627.8	1	43,209

[a]Data includes releases from relief valves, rupture discs and manual vents in VCM service. Data are for the period 8/81 - 8/83; data for months with no discharges are not included in the table.

[b]Plant shut down undefinitely on 6/83.

TABLE 6-3. SUMMARY OF 10-DAY REPORTS[a]

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
Large Reactor RVDS				
R-1	8/13/78	S	50,000	Reactor
	11/26/78	S	30,000	Reactor
	10/20/79	S	38,000	Reactor
	7/22/79	S	33,000	Reactor
	10/31/79		450	Non-reactor (VC Knockout Drum)
	3/23/80	S	10,000	Reactor
R-2	6/21/78	S	10,249	Reactor
	10/23/81		167	Non-reactor
	3/20/82	S	2,000	Reactor
	4/21/82		605	Non-reactor
	4/20/79		120	Non-reactor
R-3	7/20/78		3,000	Non-reactor (Vacuum Header)
	1/2/79	S	2,100	Reactor
	5/25/79		3,900	Non-reactor (VCM Filter)
	11/6/79	S	200	Reactor (Hydroful)
	11/26/79	S	1,560	Reactor
	3/13/80	S	4,000	Reactor
	5/5/80	S	6,500	Reactor
	5/14/80	S	2,350	Reactor
	6/4/80		4,560	Non-reactor (Stripper)
	8/1/80	S	371	Hydroful
	8/15/80		48	Non-reactor (Charge Filter)
	8/19/80		2,083	Non-reactor (VCM Sphere)
	8/20/80		96	Non-reactor (Charge System)
	9/9/80	S	17,926	Reactor
	5/15/81		104	Non-reactor (Tank)
	9/22/81		5	Non-reactor (Separator)
	4/20/82		19	Non-reactor (Charge System)
	5/22/82	S	12,090	Reactor
	6/6/82		201	Non-reactor (VCM Line)
	10/5/82	S	210	Reactor (Hydroful)
	4/21/83		19	Non-reactor (VCM Recovery)

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-4	1/NA/80		2.5	Non-reactor (VC Strainer)
	3/28/80		2.5	Non-reactor (VC Strainer)
	3/30/80		2.5	Non-reactor (VC Strainer)
	5/30/80		2.5	Non-reactor (VC Strainer)
	6/8/80		2.5	Non-reactor (VC Strainer)
	6/30/80		2.5	Non-reactor (VC Strainer)
	7/16/80		2.5	Non-reactor (VC Strainer)
	7/30/80		2.5	Non-reactor (VC Strainer)
	8/7/80		2.5	Non-reactor (VC Strainer)
	8/10/80		2.5	Non-reactor (VC Strainer)
	9/9/80		2.5	Non-reactor (VC Strainer)
	9/29/80		2.5	Non-reactor (VC Strainer)
	3/20/80		160	Non-reactor (VC Recovery)
	10/13/80		640	Non-reactor (VC Recovery)
	10/13/80		194	Non-reactor (VC Recovery)
	6/4/80		1,800	Non-reactor (VC Tank)
	6/10/80		1,800	Non-reactor (VC Tank)
	8/11/80		33	Non-reactor (Gas Holder)
	10/7/80		33	Non-reactor (Gas Holder)
	8/25/80		12	Non-reactor (Drain Tank)
	9/22/80		12	Non-reactor (Drain Tank)
	10/2/80		124	Non-reactor (VCM Line)
	10/10/80		188	Non-reactor (Charge Line)
	1/29/81		160	Non-reactor (Recovery System)
	2/22/81		3	Non-reactor (Strainer)
	3/5/81		48	Non-reactor (Recovery System)
	4/2/81		320	Non-reactor (Reflux Tank)
	4/28/81		160	Non-reactor (VC Column)
	7/28/81		2	Non-reactor (Charge Filter)
	7/31/81		1,175	Non-reactor (Reflux Tank)
	9/2/81		300	Non-reactor (VC Measure Tank)
	2/2/82		41	Non-reactor (VC Line)
R-5	4/12/78		3,000	Non-reactor (VCM sphere)
	10/21/78		7	Non-reactor (Separator)
	10/25/78		100	Non-reactor (Filter)
	11/1/78		70	Non-reactor (Separator)
	12/2/78	S	1,100	Reactor
	9/11/79		100	Non-reactor (VCM Column)
	9/17/79		300	Non-reactor (VCM Column)
	9/18/79	S	50	Reactor (Hydroful)

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-5	10/7/79	S	100	Reactor (Hydroful)
(cont'd)	10/10/79		300	Non-reactor (VCM Filter)
	11/17/79		500	Non-reactor (VCM Storage)
	11/17/79	S	100	Reactor
	2/14/80		100	Non-reactor (VCM Filter)
	5/10/80		100	Non-reactor (VCM Filter)
	7/16/80	S	100	Reactor (Hydroful)
	7/22/80		500	Non-reactor (Compressors)
	8/2/80		300	Non-reactor (Separator)
	8/4/80		200	Non-reactor (Compressors)
	8/13/80		50	Non-reactor (Filter)
	8/27/80		500	Non-reactor (VCM Tank)
	9/16/80		500	Non-reactor (Compressor)
	9/10/80		500	Non-reactor (VCM Tank)
	9/12/80		500	Non-reactor (VCM Tank)
	9/18/80		500	Non-reactor (VCM Tank)
	10/1/80		500	Non-reactor (VCM Tank)
	1/29/81		500	Non-reactor (VCM Line)
	2/7/81	S	100	Reactor
	2/19/81	S	100	Reactor
	3/19/81		100	Non-reactor (VCM Column)
	3/29/81	S	200	Reactor (Hydroful)
	3/30/81		100	Non-reactor (VCM Tank)
	4/1/81	S	100	Reactor
	4/10/81	S	200	Reactor
	5/8/81	S	200	Reactor
	5/8/81		100	Non-reactor (VCM Tank)
	5/18/81	S	200	Reactor
	5/26/81		50	Non-reactor (Exchanger)
	6/8/81		100	Non-reactor (VCM Tank)
	8/17/81		100	Non-reactor (VCM Tank)
	1/14/82		100	Non-reactor (Compressor)
	2/11/82	S	100	Reactor
	3/11/82		100	Non-reactor (Compressor)
	4/27/82		100	Non-reactor (VCM Column)
	6/29/82		50	Non-reactor (VCM Tank)
	10/14/82		50	Non-reactor (Compressor)
	12/11/82		50	Non-reactor (Compressor)
	1/25/83		100	Non-reactor (Pump)
	1/26/83	S	100	Reactor
	9/5/83	S	200	Reactor

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-6	3/24/78	S	6,000	Reactor
	1/5/79	S	10,000	Reactor (Hydroful)
	7/26/79	S	3,600	Reactor
	11/10/79	S	4,100	Reactor (Hydroful)
	11/17/79	S	12,000	Reactors (2)
	1/2/80	S	4,000	Reactor
	8/10/80	S	650	Reactor (Hydroful)
	1/14/81	S	1,680	Reactor
	5/20/81	S	715	Reactor
	8/15/82	S	8,560	Reactor
	1/15/79	NA	500	Reactor
	2/2/79	NA	4,860	Reactor (Hydroful)
	4/3/79	NA	2,500	Reactor
	9/13/79	NA	1,700	Reactor
	10/19/79	NA	2,480	Reactor
	4/13/80	NA	860	Reactor
	9/8/81	NA	155	Reactor
	7/6/82		100	Non-reactor (Weigh Tank)
	10/22/82	NA	158	Reactor (Hydroful)
	6/1/83	NA	300	Reactor
	7/19/83	NA	1,800	Reactor
R-7	NA/NA/81		500	Non-reactor (Charge Pot)
	8/NA/81	S	100	Reactor (Hydroful)
	7/NA/83	S	100	Reactor (Hydroful)
R-8	4/28/83	S	1,009	Reactor
	9/28/78	D	8,710	Reactor
	10/12/78		1	Non-reactor (Separator)
	12/3/78	S	5,000	Reactor (Hydroful)
	1/27/79		290	Non-reactor (Stripper)
	3/20/79		850	Non-reactor (Stripper)
	5/17/79		20	Non-reactor (Recirculation Line)
	9/3/79	B	3,090	Pre-polymerization Reactor
	6/NA/81	D	41,866	Reactor (6)
	11/16/82		0.35	Non-reactor (Compressor)
	7/22/82	B	1,188	Pre-polymerization Reactor
	6/12/83	B	1,192	Post-polymerization Reactor

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-9	1/4/80	S	1,213	Reactor
	7/17/83	S	100	Reactor (Hydroful)
R-10	7/28/78	S	2,774	Reactor
	9/25/78	S	163	Reactor
	6/17/79	S	570	Reactor
	7/19/79	S	1,850	Reactors (4)
	9/11/79	S	225	Reactor
	10/15/79		246	Non-reactor (Receiver Tank)
	2/10/80	S	7,356	Reactors (5)
	5/24/80	S	252	Reactor
	11/29/80	S	50	Reactor
	4/24/81		1,000	Non-reactor (Vapor Break Tank)
	5/5/81	S	750	Reactor
	6/23/81	S	2,060	Reactor
	9/24/81		1,880	Non-reactor (Vapor Break Tank)
	10/4/81	S	1,300	Reactor
	10/23/81	S	2,525	Reactor
	5/28/82	S	44	Reactor
	9/8/82	S	3,740	Reactor
R-11	1/20/78	D	575	Reactor
	3/29/78		8,000	Non-reactor (Blowdown Tank)
	4/18/78		6,750	Non-reactor (Blowdown Tank)
	4/26/78	D	1,890	Reactor
	5/2/78	D	1,375	Reactor
	5/4/78	D	2,830	Reactor
	5/22/78	D	1,360	Reactor (Blowdown Tank)
	6/5/78	L	320	Reactor
	7/3/78	S	12,600	Reactor
	8/25/78	D	1,660	Reactor
	9/30/78		7,500	Non-reactor (Blowdown Tank)
	1/1/79		700	Non-reactor (Blowdown Tank)
	1/11/79		4,973	Non-reactor (Decanter Tank)
	1/31/79	D	334	Reactor
	2/6/79	D	619	Reactor
	3/4/79		500	Non-reactor (Blowdown Tank)
	4/12/79	D	464	Reactor
	4/29/79	D	650	Reactor

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-11 (cont'd)	5/12/79		805	Non-reactor (Recovered VCM Tank)
	6/19/79		312	Non-reactor (Blowdown Tank)
	10/11/79		300	Non-reactor (Blowdown Tank)
	11/19/79		207	Non-reactor (Vent Gas Absorber)
	12/12/79		1,000	Non-reactor (Blowdown Tank)
	12/14/79		800	Non-reactor (Recovered VCM Tank)
	2/4/80	D	364	Reactor
	2/1/80	D	996	Reactor
	5/7/80		117	Non-reactor (Storage Sphere)
	5/8/80		117	Non-reactor (Storage Sphere)
	8/19/80	S	665	Reactor
	10/21/80		1,999	Non-reactor (Foam Knock-Out Tank)
	12/10/80	D	295	Reactor (Hydroful)
	1/5/81		160	Non-reactor (Blowdown Tank)
	1/5/81	S	780	Reactor
	4/5/81		365	Non-reactor (Blowdown Tank)
	5/19/81		10	Non-reactor (Recovery System)
	8/12/81	S	7,720	Reactor
	10/10/81	S	12,825	Reactor
	1/21/82		378	Non-reactor (Blowdown Tank)
	8/6/82		218	Non-reactor (Premix Tank)
R-12	7/30/79		60	Non-reactor (Storage Tank)
R-13	1/1/78	S	11,300	Reactor (Hydroful)
	1/27/78		17	Non-reactor (Transfer Strainer)
	2/16/78		68	Non-reactor (Blowdown Tank)
	3/11/78	S	10,300	Reactor
	3/14/78	D	1,312	Reactor
	3/24/78	S	9,540	Reactor (Hydroful)
	3/29/78		48	Non-reactor (Seed Tank)
	4/15/78	S	13,200	Reactor (Hydroful)
	4/17/78		114	Non-reactor (Knock-Out Tank)
	4/19/78	S	5,040	Reactor
	5/23/78		1,302	Non-reactor (Stripping Column)
	5/27/78	S	1,064	Reactor

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-13 (cont'd)	6/9/78	S	9,900	Reactor
	7/18/78		2,694	Non-reactor (Seed Tanks)
	7/22/78		8,383	Non-reactor (Blowdown & Strip Column)
	8/21/78	S	9,450	Reactor
	12/20/78	S	36	Reactor
	1/20/78		338	Non-reactor (Wastewater Stripper Tank)
	3/8/78		38	Non-reactor
	5/11/79	S	4,188	Reactors (6)
	6/5/79	D	9,817	Reactor (Hydroful)
	6/13/79	S	1,922	Reactor
	11/19/79	S	9,500	Reactor
	12/5/79		79	Non-reactor (Seed Tank)
	2/9/80	D	8,600	Reactor (Hydroful)
	2/24/80	D	8,200	Reactor (Hydroful)
	4/10/80		284	Non-reactor (Seed Tank)
	6/15/80		10,092	Non-reactor (Seed Tank)
	6/28/80		110	Non-reactor (Rail Car)
	7/9/80	S	2,775	Reactor
	7/28/80		100	Non-reactor (Rail Car)
	9/10/81		511	Non-reactor ("Burp" Tank & Blowdown Tank)
R-14	4/3/78	S	25	Reactor
	2/12/79	S	500	Reactor
	3/20/82	S	2	Reactor
	6/4/83	S	11	Reactor (Hydroful)
R-15	8/30/78	S	725	Reactor
	10/22/78	S	1,200	Reactor
	3/22/79	S	1,100	Reactor
	3/13/81	S	2,275	Reactor
	5/8/81	S	425	Reactor
	5/21/81	S	83	Reactor
	5/29/81	S	3,425	Reactor
	6/25/81	S	4,383	Reactor
	10/19/81	S	2,499	Reactor
	12/5/81	S	2,225	Reactor (Hydroful)
	5/12/82	S	418	Reactor

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-16		No 10-day reports		
R-17	9/17/78	S	1,240	Reactor
	12/19/78		600	Non-reactor (Recovery Comp.)
	4/15/79		350	Non-reactor (Recovery Comp.)
	4/8/79		525	Non-reactor (Recovery Comp.)
	4/5/79		595	Non-reactor (Recovery Comp.)
	4/2/79		280	Non-reactor (Recovery Comp.)
	3/29/79		525	Non-reactor (Recovery Comp.)
	3/18/79		350	Non-reactor (Recovery Comp.)
	2/21/79		525	Non-reactor (Recovery Comp.)
	2/12/79		350	Non-reactor (Recovery Comp.)
	1/24/79		525	Non-reactor (Recovery Comp.)
	1/21/79		560	Non-reactor (Recovery Comp.)
	1/11/79		510	Non-reactor (Recovery Comp.)
	1/5/79		525	Non-reactor (Recovery Comp.)
	9/29/80	S	3,480	Reactor
	11/9/81	S	585	Reactor
	1/20/83	S	3,830	Reactor
R-18	1/28/78	NA	2,929	Reactor
	3/2/78		741	Non-reactor (Blowdown Tank)
	3/6/78		164	Non-reactor (Blowdown Tank)
	6/14/78		98	Non-reactor (Blowdown Tank)
	6/18/78	NA	98	Reactor (Hydroful)
	7/31/78		58	Non-reactor (Blowdown Tank)
	8/5/78		53	Non-reactor (Hydroful)
	8/26/78		16	Non-reactor (Blowdown Tank)
	9/21/78		286	Non-reactor (Storage Tank)
	11/19/78		207	Non-reactor (Blowdown Tank)
	11/22/78	NA	1,500	Reactor
	11/30/78		206	Non-reactor (Blowdown Tank)
	3/30/79		309	Non-reactor (Blowdown Tank)
	4/20/79		120	Non-reactor (Low-Pressure Steam Line)
	5/26/79	NA	1,260	Reactor (Hydroful)
	8/28/79		420	Non-reactor (VCM Tank)
	1/14/80	NA	25	Reactor (Hydroful)
	3/2/80	S	8,220	Reactor
	3/6/80	NA	41,866	Reactors (6)

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-18 (cont'd)	7/11/80		997	Non-reactor (Wastewater Stripper Tank)
	10/18/80	D	580	Reactor
	2/NA/81		17	Non-reactor (Blowdown Tank)
	5/30/81	NA	346	Reactor
	10/8/81		206	Non-reactor (Blowdown Tank)
	10/23/81		167	Non-reactor (Blowdown Tank)
	7/2/82	NA	170	Reactor (Hydroful)
	8/15/82		3,146	Non-reactor (Surge Tank)
	9/10/82		817	Non-reactor (Surge Tank)
	10/7/82	NA	6	Reactor (Hydroful)
	10/7/82		14	Non-reactor (Sump)
	3/7/80	NA	1,329	Reactor (Hydroful)
	3/7/80	NA	44	Reactor (Hydroful)
R-19	1/8/78	S	1,840	Reactor
	1/5/78		856	Non-reactor (Degasser)
	1/7/78	S	85	Reactor
	1/10/78	S	3,982	Reactor
	1/11/78	S	993	Reactor
	1/11/78	S	136	Reactor
	1/13/78	S	331	Reactor
	1/19/78	S	5,800	Reactor
	1/20/78		39	Non-reactor (Vacuum System)
	1/28/78	S	1,074	Reactor
	2/9/78		438	Non-reactor (Degasser)
	2/12/78	S	585	Reactor (Hydroful)
	2/13/78	S	331	Reactor
	2/14/78	S	321	Reactor
	2/16/78	S	1,954	Reactor
	2/28/78		692	Non-reactor (Degasser)
	2/28/78	S	3,196	Reactor (Hydroful)
	3/10/78	S	8,390	Reactors (2)
	3/13/78	S	585	Non-reactor (Vacuum System)
	3/13/78		5,997	Reactor
	3/17/78	S	1,990	Reactor
	3/30/78		59	Non-reactor (Knock-Out Drum)
	4/6/78	D	68	Reactor
	4/19/78	S	73	Reactor
	4/24/78	S	3,840	Reactor
	5/1/78	S	265	Reactor (Hydroful)

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-19	5/2/78	S	9,551	Reactor
(cont'd)	5/16/78		146	Non-reactor (Degasser)
	6/1/78	S	208	Reactor (Hydroful)
	6/7/78	S	159	Reactor
	7/14/78	S	52	Reactor (Hydroful)
	8/3/78	S	880	Reactor
	8/10/78	S	28	Reactor
	8/16/78		600	Non-reactor (Vacuum System)
	9/25/78		300	Non-reactor (Vacuum System)
	9/24/78	S	60	Reactor (Hydroful)
	9/2/78	S	28	Reactor (Hydroful)
	9/2/78	S	52	Reactor (Hydroful)
	9/24/78		40	Non-reactor (Vacuum System)
	9/24/78	S	106	Reactor (Hydroful)
	9/22/78	S	53	Reactor (Hydroful)
	10/6/78	S	640	Reactor
	10/19/78	D	23	Reactor
	10/18/78	D	25	Reactor
	10/28/78	D	20	Reactor
	11/7/78	S	11,130	Reactor
	11/7/78	S	260	Reactor
	11/13/78	S	6,240	Reactor
	12/9/78	S	2,790	Reactor (Hydroful)
	3/30/78	D	58	Reactor
	3/12/78	D	150	Reactor
	1/2/79	D	9,850	Reactor
	1/11/79	S	320	Reactor
	1/15/79		1,305	Non-reactor (Degasser)
	1/23/79	S	2,560	Reactor (Hydroful)
	1/29/79		20	Non-reactor (Vacuum System)
	2/7/79		20	Non-reactor (Vacuum System)
	2/10/79	S	530	Reactor (Hydroful)
	2/13/79	S	40	Reactor
	3/25/79	S	200	Reactor
	4/10/79	S	60	Reactor
	4/12/79	S	9,540	Reactor
	4/20/79	D	40	Reactor (Hydroful)
	4/29/79	D	53	Reactor (Hydroful)
	8/10/79	S	1,060	Reactor
	3/6/80	NA	315	Reactor
	4/12/80	NA	10,870	Reactor

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-19 (cont'd)	4/20/80	NA	8,300	Reactor
	4/16/80	NA	2,400	Reactor
	5/12/80	NA	410	Reactor
	7/5/80	NA	555	Reactor
	7/27/80	NA	72	Reactor
	9/17/80	NA	13,200	Reactor
	10/28/80	NA	1,140	Reactor
	2/13/81	S	1,575	Reactor
	3/17/81		51	Non-reactor (Degasser)
	4/7/81	S	105	Reactor
	4/10/81	S	220	Reactor
	4/10/81	S	3,420	Reactor
	4/15/81		20	Non-reactor (Vacuum System)
	5/20/81	D	6,300	Reactor
	7/8/81		20	Non-reactor (Vacuum System)
	10/2/81	S	36	Reactor
	1/11/82	S	2,880	Reactor
	1/11/82	S	5,760	Reactor
	1/11/82	S	2,880	Reactor
	4/30/82	S	1,070	Reactor
	8/14/82	D	3,210	Reactor
R-20	1/24/78	B	750	Post-polymerization Reactor
	2/4/78	B	900	Post-polymerization Reactor
	4/14/78	B	1,500	Post-polymerization Reactor
	4/15/78	B	1,750	Post-polymerization Reactor
	4/28/78	B	700	Post-polymerization Reactor
	4/30/78	B	650	Post-polymerization Reactor
	5/30/78	B	1,200	Post-polymerization Reactor
	6/1/78	B	3,000	Post-polymerization Reactor
	6/7/78	B	1,200	Pre-polymerization Reactor
	6/11/78	B	8,000	Post-polymerization Reactor
	7/28/78	B	1,000	Post-polymerization Reactor
	9/21/78	B	2,500	Post-polymerization Reactor
	11/21/78	B	1,200	Post-polymerization Reactor
	12/15/78	B	1,500	Post-polymerization Reactor
	12/30/78	B	1,000	Post-polymerization Reactor
	4/27/79	B	3,200	Post-polymerization Reactor
	6/29/79	B	2,800	Post-polymerization Reactor
	9/9/79	B	1,000	Post-polymerization Reactor
	10/12/79	B	3,500	Post-polymerization Reactor

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-20	11/6/79	B	600	Post-polymerization Reactor
(cont'd)	12/26/79	B	500	Post-polymerization Reactor
	3/3/80	B	2,000	Pre-polymerization Reactor
	7/17/80	B	2,700	Post-polymerization Reactor
	2/17/81	B	700	Post-polymerization Reactor
	2/26/81	B	1,750	Post-polymerization Reactor
	4/25/81	B	1,500	Post-polymerization Reactor
	4/28/81	B	1,100	Post-polymerization Reactor
	6/14/81	B	8,000	Post-polymerization Reactor
R-21	3/31/81	B	105	Pre-polymerization Reactor
R-22	12/11/78		5	Non-reactor (Incinerator Surge Tank)
	8/16/78	B	4,500	Post-polymerization Reactor
	8/16/78	B	4,000	Post-polymerization Reactor
	5/29/78	B	900	Pre-polymerization Reactor
	5/4/78	B	6,000	Post-polymerization Reactor
	1/31/79	B	3,000	Post-polymerization Reactor
	2/14/79	B	13,000	Post-polymerization Reactor
	3/14/79	B	7,000	Post-polymerization Reactor
	4/5/79	B	800	Pre-polymerization Reactor
	5/1/79	B	500	Post-polymerization Reactor
	6/15/79	B	1,000	Post-polymerization Reactor
	6/16/79	B	4,000	Post-polymerization Reactor
	6/24/79	B	8,000	Post-polymerization Reactor
	8/6/79	B	700	Post-polymerization Reactor
	8/9/79	B	2,250	Post-polymerization Reactor
	1/27/80	B	300	Post-polymerization Reactor
	2/1/80	B	4,940	Post-polymerization Reactor
	1/21/80	B	3,000	Post-polymerization Reactor
	7/7/80	B	500	Post-polymerization Reactor
	7/9/80		25	Non-reactor (VC Filter)
	7/10/80	B	3,500	Post-polymerization Reactor
	8/6/80		100	Non-reactor (VC Filter)
	9/6/80	B	5,360	Post-polymerization Reactor
	10/26/80	B	560	Post-polymerization Reactor
	11/19/80		35	Non-reactor (VC Filter)
	12/18/80	B	600	Post-polymerization Reactor
	1/4/82	B	3,500	Post-polymerization Reactor
	6/16/82	B	1,500	Pre-polymerization Reactor

TABLE 6-3. (Continued)

Plant Code	Date	Resin Type[b]	Reported Lbs of Discharge	Source
R-22	6/30/82		1,000	Non-reactor (Booster Pump)
(cont'd)	10/25/82	B	3,655	Post-polymerization Reactor
	11/16/82	B	400	Post-polymerization Reactor
	3/21/83	B	4,000	Pre-polymerization Reactor
	3/28/83	B	3,250	Post-polymerization Reactor
	4/29/83	B	250	Post-polymerization Reactor
	5/30/83	B	3,380	Post-polymerization Reactor
R-23	10/6/78	So	4,586	Reactor
	6/3/79	So	5,123	Reactor
	8/6/79	So	7,838	Reactor and Stripper

NA = Not available.

[a]Compliance reports required within ten days of a relief valve discharge occurrence.

[b]Resin type code: S = suspension
D = dispersion
L = latex
B = bulk
So = solution

Resin type listed for reactor discharges only.

TABLE 6-4. AVERAGE CAPACITY UTILIZATION RATES FOR VC AND PVC PRODUCTION[a]

Year	Capacity Utilization Rates VC	Capacity Utilization Rates PVC
1983	62.0%[b]	62.2%[b]
1982	62.0	62.2
1981	66.2	70.7
1980	80.4	71.9
1979	93.2	87.4
1978	88.5	85.4

[a]Source: Chemical Marketing Reporter. July 5, 1982.

[b]Assumed to be the same as in 1982.

TABLE 6-5. ESTIMATED TYPICAL NUMBER OF BATCHES PER REACTOR

	Suspension				
	Large Reactor	Small Reactor	Dispersion	Latex	Bulk
1978	1,000	750	450	300	480
1979	1,030	780	460	310	490
1980	840	630	380	250	410
1981	830	620	370	250	400
1982	680	550	320	220	350
1983	1,000	720	420	290	500

TABLE 6-6. PRODUCTION CAPACITY OF PVC PLANTS[a]

	Location	Annual Capacity Millions of Lbs					
		83	82	81	80	79[b]	78
Air Products	Calvert, KY	200	200	200	220	120	128
	Pensacola, FL	200	200	200	200	150	150
Borden, Inc	Illiopolis, IL	320	320	340	340	400	400
	Leominster, MA	200	200	185	185	145	145
CertainTeed	Lake Charles, LA	190	190	190	190	200	200
Conoco	Aberdeen MI	455	455	335	335	195	195
	Oklahoma City, OK	260	260	215	215	200	200
Ethyl	Baton Rouge, LA	180	180	180	180	180	180
	Delaware City, DL	150					
Formosa Plastics	Delware City, DL	280	280				
	Point Comfort, TX	530					
General Tire & Rubber	Ashtabula, OH	125	125	125	125	125	125
Georgia-Pacific Corp.	Plaquemine, LA	700	700	700	350	350	350
BF Goodrich	Avon Lake, OH	400	400	300	300	300	300
	Deer Park, TX	260	260				
	Henry, IL	200	200	200	200	200	200
	Long Beach, CA	150	150	150	150	150	150
	Louisville, KY	375	375	375	375	500	500
	Pedricktown, NJ	400	350	350	150	150	150
	Plaquemine, LA	190	190	190	190	200	200

TABLE 6-6. (Continued)

	Location	Annual Capacity Millions of Lbs					
		83	82	81	80	79[b]	78
Goodyear Tire & Rubber	Niagara Falls, NY	70	70	70	70	70	70
Keysor Corp.	Saugus, CA	50	50	50	50	35	35
Occidental	Addis, LA	220	220	220			
	Burlington, NJ	190	190	190	190	180	180
	Pottstown, PA	240	240	240			
Pantasote	Passaic, NJ	55	55	55	55	60	60
Shintech, Inc.	Freeport, TX	680	680	330	330	220	220
Talleyrand	New Bedford, MA	78	78	78			
Tenneco	Burlington, NJ	160	160	160	160	155	155
	Flemington, NJ	105	105	105	80	80	80
	Pasadena, TX	700	700	480	480	270	270
Union Carbide	South Charleston, WV	50	50	50	50	55	55
	Texas City, TX	125	125	125	125	200	200
Diamond Shamrock	Deer Park, TX	130	400	470	470	470	470

[a]Source: SRI Directory of Chemical Producers.

[b]Capacities were not available for 1979 and were assumed to be the same as 1978 capacities.

TABLE 6-7. SUMMARY OF 10-DAY REPORTS[a] FOR EDC/VC PLANTS

Plant Code	Date Of Discharge	Amount Of Discharge (Lbs)	Source of Discharge
RE-1	6-1-78	400	VCM Check Tank
	6-16-78	125	VCM Dryer
	7-3-78	31.7	Incineration Knock-Out Drum
	7-14-78	7.6	Fuel-Rich Seal Pot
	7-25-78	14.0	O_2 Rich Vent Gas Seal Drum
	11-15-78	56	Incinerator
	4-21-79	453	VCM Check Tank
	5-14-79	257	Preheater
	5-24-79	257	Stripper Column
	6-27-79	292	Quench Column
	8-6-79	169	VCM Storage Tank
	9-25-79	1,210	VCM Transfer Line
	3-17-80	594	HCl Column
	1-4-81	17	VCM Rework Pump
	2-26-81	86	Vinyl Chloride Column
	5-11-81	418	VCM Dryer
	7-8-81	25	Wet Vent Header System
	8-11-81	2,415	VCM Dryer
	5-12-78	3.7	Quench Tower
	8-12-78	0.2	O_2-Lean Seal Pot
RE-2	1-23-78	NA	Storage Spheres
	2-28-80	10	Oxchlorination Prereactors
	12-1-80	475	Column (Unspecified)
	2-9-81	9	VC Line
	2-17-82	<100	Filter
	8-5-82	3,600	Transfer Line
	11-2-82	8,500	Vinyl Furnace
	12-12-82	40	Vinyl Sphere
RE-3	12-20-82	40	Transfer Line
	1-5-83	3,700	VCM Caustic Mixer
	1-27-83	650	VCM Purification Column
	7-21-83	810	VCM Surge Tank
RE-4	8-1-80	107	VCM Tank
	7-16-80	2,600	Check Tank
	5-15-80	18	Check Tank
	5-4-80	300	NA
	3-10-80	27	VCM Storage Tank
	3-8-80	23	VCM Storage Tank

TABLE 6-7. (Continued)

Plant Code	Date Of Discharge	Amount Of Discharge (Lbs)	Source of Discharge
RE-4 (cont'd)	2-23-80	7.5	VCM Check Tank
	3-22-80	140	VCM Column
	5-23-79	160	VCM Column
	5-23-79	4,000	VCM Check Tank
	5-18-79	110	VCM Check Tank
	5-16-79	600	VCM Column
	5-10-79	2,000	VCM Check Tank
	1-4-78	1,170	NA
RE-5	8-26-83	2.2	VCM Check Tank
	5-16-83	1,226	VCM Column
	11-13-81	609	VCM Column
	11-13-81	384	Caustic Decanter
	11-3-81	1,671	NA
	8-25-81	77	Caustic Decanter
	10-26-80	1,990	Quench Column
	10-24-80	2,500	Caustic Decanter
	7-16-80	4	HCl Column
	10-3-79	1,534	Drying Beds
	11-8-82	0.6	VCM Product Filter
	8-5-82	133	Caustic Decanter
	6-8-82	885	Caustic Decanter
	6-20-82	94	Caustic Decanter & Caustic Dryer
RE-6	2-8-82	1	HCl Column
	2-9-82	11,000	VC Column
	12-4-81	200	Rework Stripper
	7-31-81	NA	HCl and VC Columns
	6-5-81	100	VC Bullet
	3-26-81	15 - 20	VC Filtering System
	12-5-80	1	Loading Line
	4-14-80	2,949	VCM Relux Column
	1-23-80	347	VC Column
	12-20-79	92	VC Bullets
	12-19-79	400	HCl Column
	3-1-79	11	Lights & VCM Column
	4-9-79	158	HCl Stripper
	1-24-79	3.1	HCl Column

TABLE 6-7. (Continued)

Plant Code	Date Of Discharge	Amount Of Discharge (Lbs)	Source of Discharge
RE-7	12/20/81	103	Vent Gas Knockout Drum
	12/22/81	1.9	Liquid Knockout Drum
	12/22/81	3	Liquid Knockout Drum
	1/18/82	2,700	VCM Sphere
	1/24/82	350	Liquid Knockout Drum
	2/20/82	4	Liquid Knockout Drum
	5/6/82	2,670	EDC Furnace
	5/6/82	620	Quench Column
	10/30/82	9,600	Light Ends Column
	10/31/82	620	Overhead Storage Drum
RE-8	4-16-82	1,150	Finishing Column Condenser
	8-10-79	3,400	VCM Tank Car
	3-19-79	2,600	Storage Vessel
	11-2-78	12	Tank Car Loading Line
	3-30-78	12	Tank Car Loading Line
RE-9	4-27-82	1,920	Transfer Line
	3-25-82	13,878	Product Storage Vessel
	2-17-82	72	Not Available
	9-29-81	30	Transfer Line
	9-18-81	5	Product Transfer Line
	7-20-81	29	Product Transfer Line
	7-19-81	NA	NA
	7-5-81	NA	Fill Line
	7-7-81	10	VC Transfer Line
	6-24-81	4	
	6-30-81	72	Transfer Line
	6-4-81	4,400	Storage Sphere
	6-3-81	700	Storage Sphere
	6-5-81	45	Loading Line
	5-28-81	1,700	Transfer Line
	5-23-81	1,700	Transfer Line
	6-2-81	1,100	Transfer Line
	6-3-81	2,400	Transfer Line
	5-7-81	20	Transfer Line
	4-15-81	500	Unloading Line
	10-13-78	9	Transfer Line
	7-25-78	100	Transfer Line

TABLE 6-7. (Continued)

Plant Code	Date Of Discharge	Amount Of Discharge (Lbs) .	Source of Discharge
RE-10	3-28-81	1.2	Light EndsStorage Vessel
	9-8-79	7,000	Quench Column
	9-1-79	700	HCl Stripping Column
	6-1-79	5,000 - 10,000	VCM Rundwon Sphere
	1-30-79	22	Filter Valve
	1-14-79	10	HCl Stripper Column
	4-30-78	7,500	VCM Column
	6-19-82	80	Accumulator Vessel
RE-11	5-11-81	1,027	NA
	8-27-80	4	NA
	9-9-80	65	Knock Out Drum
	1-2-80	378	Vessel (Unspecified)
	7-28-79	6,000	Vessel (Unspecified)
	5-27-79	209	Vinyl Transfer Line
	5-8-79	73	Quench Area
	10-20-78	185	Process Compressors
	9-16-78	1,700	Vessel
	8-31-78	6,000	Compressors
	5-23-78	12,000	Tank
	2-18-78	3,300	Compressor
RE-12	11/12/80	1,670	VCM Sphere
	10/8/81	53	VCM Humidifier Vessel
	1/5/81	4,620	VCM Sphere
	9/29/81	450	Neutralizer Vessel
	5/6/83	84	Reflux Drum on Product Still
RE-13	1/6/80	10	Incinerator Vent Line
	3/7/80	128	Vapor Header
	5/31/80	34.4	NA
	7/29/80	129.9	Wet VC Header
	7/30/80	53.7	EDC Stripout Tank
	7/30/80	206.8	Wet VCl Header
	12/10/80	0.5	Wet VCl Header
	12/20/80	1.5	Wet VCl Header
	2/1/81	133	VCM Sphere
	12/8/81	33.3	Vent Header
	12/22/81	46,556	(3RVDs) Dry VCl Header VCl Column (2)

TABLE 6-7. (Continued)

Plant Code	Date Of Discharge	Amount Of Discharge (Lbs)	Source of Discharge
	4/30/82	81.6	Wet VCl Header
	6/2/82	43,209	(5 RVDs) VCl Column (3) VCl Reboiler VCl Reflux Drum

NA = not available.

[a]Compliance reports required within ten days of a relief valve discharge occurrence.

TABLE 6-8. PRODUCTION CAPACITY OF EDC/VC PLANTS[a]

		Annual Capacity Millions of Lbs VC						
	Location	83	82	81	80	79[b]	78	77
Borden Inc.	Geismar, LA	610	610	380	380	300	300	300
Dow	Freeport, TX	150	150	150	150	200	200	200
	Oyster Creek, TX	750	750	750	750	700	700	700
	Plaquemine, TX	1,250	1,250	1,250	1,250	1,250	1,250	1,250
Conoco	Lake Charles	700	700	700	700			
Ethyl	Baton Rouge, LA	300	300	300	300	300	330	330
Formosa Plastics	Baton Rouge, LA	300	300					
	Point Comfort, TX	530						
Georgia Pacific	Plaquemine, LA,	1,000	1,000	1,000				
BF Goodrich	Calvert City, KY	1,000	1,000	1,000	1,000	1,000	1,000	1,000
	Lake Porte, TX	1,000	1,000	1,000	1,000	1,000	1,000	1,000
PPG Industries	Lake Charles, LA	900	900	400	400	400	400	400
Shell Chemical	Deer Park, TX	840	840	840	840	840	840	840
	Norco, LA	700	700	700	700	700	700	700

[a]Source: SRI Directory of Chemical Producers.

[b]Capacities were not available for 1979 and were assumed to be the same as 1978 capacities.

APPENDIX A

MEMORANDUM: VINYL CHLORIDE STANDARD - NUMERICAL LIMITS FOR RELIEF VALVE DISCHARGES

RADIAN
CORPORATION

MEMORANDUM

DATE: April 16, 1984

TO: File

FROM: Reese H. Howle, Karen K. Fidler

SUBJECT: Vinyl Chloride Standard - Numerical Limits for Relief Valve Discharges

SUMMARY

Relief valve discharge performance by polyvinyl chloride (PVC) and ethylene dichloride/vinyl chloride (EDC/VC) plants was analyzed to determine numerical limits that would reflect an upper limit (i.e., never-to-be exceeded) performance level that is representative of compliance with the current format of the VC standard for relief valve discharges. The analysis resulted in selection of the following 12-month limits:

(1) Discharges from PVC reactors
(suspension, dispersion, latex, bulk processes)

- Reactors
  - suspension resin process — 0.035 discharges/100 batches
  - dispersion resin process (including latex resin) — 0.035 discharges/100 batches
  - bulk resin process — 0.035 discharges/100 batches
- Nonreactor sources — 0.025 discharges/100 batches, not exceeding 3 discharges/yr

(2) Discharges from PVC plants (solution and other continuous processes) — 1 discharge/yr

(3) Discharges from EDC/VC plants — 4 discharges/yr

This memo describes the approach for determining these limits.

BACKGROUND

The current national emission standard for VC was promulgated under Section 112 of the Clean Air Act in 1976. A review of the standard was performed to investigate the adequacy and appropriateness of the standard in light of policy decisions, health studies, control technology developments, and enforcement and compliance experience which occurred since the standard was promulgated. As written, the standard prohibits all but "emergency" relief valve discharges. One finding of the review was that considerable enforcement resources are being expended by the EPA to assess the preventability of individual discharges. Second, industry has expressed continual uncertainty regarding whether they are in compliance with the standard. In response to these problems, an investigation was performed to identify ways to reformat the standard with alternative numerical limits representative of compliance with the current format of the standard.

Data on relief valve discharge performance by the VC industry was obtained from three sources. First, the Vinyl Institute (VI) provided relief valve discharge performance data obtained through a survey of their member companies (19 PVC plants and 10 EDC/VC plants). Second, regional compliance data on relief valve discharges was gathered for 23 PVC plants and 13 EDC/VC plants. Third, trip reports documenting visits to five PVC plants provided information on control techniques used to prevent relief valve discharges. An analysis of the collected performance data was undertaken to determine an upper limit performance level that represents compliance with the current standard format. Based on the analysis, a series of numerical limits for relief valve discharges are recommended for incorporation in the standard. The approach for determining these numerical limits is described below.

APPROACH FOR DETERMINING LIMITS

The approach for determining numerical limits was based on examination of recent relief valve discharge performance of PVC and EDC/VC plants within the industry. Recent performance best reflects efforts by the VC industry to comply with the current standard as evidenced by the general improvement in relief valve discharge performance by plants since the standard went into effect. Attached Table 1 illustrates this trend toward improved relief valve discharge performance. The performance data in Table 1 is based on 10-day compliance reports submitted to EPA regional offices. Attached Table 2 presents recent relief valve discharge performance data derived from the VI survey of their member companies. Because we were unable to obtain all of the relief valve discharge data from EPA regional offices, the VI data were generally more complete for the recent periods covered; further, the discharge per 100 batches figures presented in the VI data are based on actual production data. For these reasons, they were used as the basis for selecting the numerical limits. The regional compliance data includes reasons why each discharge occurred. Consequently, the regional compliance data were used to verify achievability of the limits determined using the VI data. The two data bases represented in Tables 1 and 2 are described in more detail in the Radian report, "Relief Valve Discharge Performance Under Current Vinyl Chloride Standard." In both data sets presented here, performance is expressed for twelve month periods rolling every six months.

Two basic formats were considered for expressing relief valve discharge performance by PVC and EDC/VC plants to serve as the basis for determining numerical limits. The selected format is based on discharge frequency rather than mass of discharge since a sufficiently accurate method for measuring discharge quantities has not been identified. For PVC plants with batch production processes (i.e., suspension, dispersion, latex, and bulk processes), the opportunity for discharges appears to be related to the number of times a new polymerization batch is initiated. For PVC plants with continuous production processes (i.e., solution process) and EDC/VC plants, discharge frequency is not related to any batch sequence. For purposes of evaluating discharge performance to determine numerical limits for relief valve discharges, performance by batch process PVC producers is expressed in terms of discharge frequency per batch. Relief valve discharge performance by continuous process PVC producers and EDC/VC producers is expressed in terms of annual discharge frequency.

As indicated in Table 2, recent relief valve discharge performance of PVC plants ranges from 0 to 0.225 discharges per 100 batches. Relief valve discharge performance of EDC/VC plants in Table 2 ranges from 0 to 7 discharges per year. The performance level representative of compliance with the current standard is somewhere within these ranges of performance. The current standard does not prohibit all discharges but rather all "nonemergency" discharges. Consequently, it was anticipated that plants could continue to have some discharges without being in violation of the standard. As expected, recent performance data indicate that relief valve discharges continue to occur at most plants. However, some plants are performing better than others. The analysis for determining the upper limit performance level representative of compliance with the current standard format was performed separately for PVC and EDC/VC plants.

PVC Plants

The first step in determining what performance level is representative of compliance with the current relief valve discharge standard format for PVC plants was to perform a detailed evaluation of plants with good compliance histories. Five PVC plants were selected which have been successful in preventing or reducing the frequency of relief valve discharge occurrences. Based on information obtained during visits to the five plants, it was judged that hardware and operational practices at each of the visited plants represent reasonable relief valve discharge control measures consistent with the intent of the current standard. Although the combination of controls used at each plant varies, each has been effective in reducing the frequency of relief valve discharges. The resulting relief valve discharge performance by the five plants varies. These variations in performance can be partly attributed to varying levels of sophistication in hardware controls. For example, some of the visited plants were equipped with computer control and relatively high levels of instrument redundancy, both of which are associated with control of relief valve discharges. In comparison, one plant had no computer control and only minimal redundant instrumentation. Performance by the plants with more sophisticated hardware controls was typically better than the less sophisticated plant. However, hardware items such as computer control and high levels of instrument redundancy were not required by EPA to comply with the current standard.

Instead, an effective combination of operational practices, hardware controls, and attitude toward prevention of discharges are required to meet the standard. The less sophisticated plant described above has successfully reduced relief valve discharge occurences by an effective combination of attitude, operational practices and minimal hardware.

Four of the five plants evaluated in detail produce suspension resins. As seen in Table 2, the performance of three of the four plants ranges from 0.018 to 0.034 discharges per 100 batches for reactor discharges. The fourth suspension plant is not included in Table 2 (i.e., not a VI member company). Performance of this plant did not exceed 0.010 discharges per 100 batches for the same period (8/81-7/83). Based on the upper level of performance (i.e., largest number of discharges per 100 batches) of the four plants that produce suspension resins, a numerical limit of 0.035 discharges per 100 batches was selected as an upper limit on performance representative of compliance with the current standard format.

Two of the five PVC plants produce dispersion resins along with other resin types. Neither had a dispersion reactor discharge during the period represented in Table 2. In fact, only one plant included in the VI survey experienced any relief valve discharges from a dispersion reactor. Likewise, only one plant producing latex resins experienced any relief valve discharges from latex reactors. Since the dispersion and latex resin production processes are based on nearly identical technology, they were combined for purposes of selecting a numerical limit for relief valve discharges. Because the potential for an emergency discharge always exists, a limit for discharges from dispersion and latex reactors was selected on the basis of a single emergency discharge occurrence. Based on the relief valve discharge performance data in Table 2, a limit of 0.035 discharges per 100 batches represents a single discharge from a plant producing a typical number of dispersion or latex resin batches. Therefore, a limit of 0.035 discharges per 100 batches for dispersion and latex reactors was selected as an appropriate upper limit on performance representative of compliance with the current standard format for these sources.

Bulk resins are produced at two of the five plants. Relief valve discharge performance by one of these two bulk plants is presented in the VI data in Table 2. The other bulk plant, not represented in Table 2, experienced no discharges during the period 8/81-7/83. Of the remaining two producers of bulk resins presented in Table 2, relief valve discharge performance by one is much higher. Performance by the second plant demonstrates considerable improvement to a level comparable to the visited plants. Based on recent performance of the two visited bulk plants and the third recently improved bulk plant, a limit of 0.035 discharges per 100 batches also seems to be the appropriate upper limit on performance representative of compliance with the current standard format.

A limit for nonreactor discharges at PVC plants that produce suspension, dispersion (including latex) and bulk resins was also selected on the basis of a detailed evaluation of performance by the five plants. From Table 2, the range of recent nonreactor relief valve discharge performance for three of the five plants was 0 to 0.024 discharges per 100 batches. Two of the five plants are not included in the VI data in Table 2. Neither of these two plants had a nonreactor discharge during the period covered. As before, the upper level of nonreactor relief valve discharge performance by the visited plants was judged to be representative of compliance with the current standard format. Based on the recent performance by the five plants, a limit for PVC nonreactor discharges of 0.025 discharges per 100 batches was selected. Because of the wide variation in the annual number of polymerization batches produced at different plants, a limit of 0.025 discharges per 100 batches would allow some plants only one discharge per year and other plants as many as 5 discharges per year. Further examination of the nonreactor relief valve discharge performance data for all PVC plants in Table 2 revealed that only two plants had more than 3 discharges in one year. Batch production by these two plants were small to average relative to other plants. A higher number of allowable discharges does not appear to be warranted for plants with larger production. Therefore, a limit of 3 discharges per year is specified for PVC nonreactor discharges (in addition to the limit of 0.025 discharges per 100 batches) as representative of compliance with the current standard format.

The solution process is currently used by one plant to produce PVC. Unlike the batch production processes used for other resin types, the solution process is continuous. Consequently, no separation was made between reactor and nonreactor discharges in expressing relief valve discharge performance by this plant. As indicated in Table 1, relief valve discharge frequency by this plant has been zero for each of the 12-month periods after 1980. Previously, as many as 2 discharges were reported during the indicated 12-month periods. Although recent performance suggests that relief valve discharges have been eliminated by this plant, a limit of one discharge per year was selected to allow for the potential unanticipated emergency discharge.

Relief valve discharge performance in Table 2 was reviewed to see how PVC plants are performing relative to the recommended numerical limits. Based on the recent performance shown in Table 2, 16 of the 17 (94 percent) suspension plants in Table 2 are performing within the recommended limit for suspension reactor discharges (i.e., 0.035 discharges per 100 batches). All of the dispersion and latex plants in Table 2 are performing within the recommended limit of 0.035 discharges per 100 batches for dispersion and latex reactor discharges. One of 3 (33 percent) bulk plants are performing within the recommended limit of 0.035 discharges per 100 batches for bulk reactor discharges. Fifteen of 19 (79 percent) PVC plants represented in Table 2 are performing within the recommended limit of 0.025 discharges per 100 batches for nonreactor discharges. All together, 12 of 19 (63 percent) PVC plants represented by the VI data are performing within the recommended limits for all source and resin type categories. In addition, the single solution process PVC plant (not represented in the VI data) is performing within the recommended limit of one discharge per year. Review of the performance data in Table 2 also shows the bimodal nature of the relief valve discharge performance for the various plants. In general, either the plants are achieving the recommended limits or they are exceeding them by a wide margin (i.e., 0.035 vs. 0.059 to 0.125 discharges per 100 batches for reactor discharges; 0.025 vs. 0.043 to 0.225 discharges per 100 batches for nonreactor discharges).

To verify that the recommended numerical limits for relief valve discharges at PVC plants reflect compliance with the current standard format, reasons for plant performance worse than that of visited plants were examined. For each case where individual plant performance was worse than the recommended numerical limits, the performance was calculated after identification and elimination of "preventable" discharges. The criteria for identifying "preventable" discharges is described below.

Based on information gathered from plant visits, contacts with regional offices, 10-day compliance reports, and vendors, it was judged that certain types of discharges can be prevented by reasonable measures. For example, discharges caused by operator error, due to operator negligence or failure to follow standard operating procedures (SOP), were considered clearly "preventable." In addition, operator errors resulting from insufficient training or lack of established SOP were judged clearly "preventable." Based on information obtained from visited plants, effective operator training programs can minimize operator error related relief valve discharges. Another example of "preventable" discharges is discharges due to premature releases from relief devices. Premature releases occur when a relief device releases at a pressure lower than the rated pressure of the relief device. This occurs most frequently from the premature bursting of the rupture disc. According to plant visit discussions, plants with routine maintenance for rupture discs and safety relief valves have been able to eliminate premature releases. Finally, discharges recurring for the same reasons as previous discharge incidents were considered "preventable." Such recurring discharges indicate failure to adopt appropriate preventive measures in response to the initial discharge occurrence.

Although other causes for specific discharge occurrences may be preventable, this assessment would need to be done on a case-by-case basis and would require, in many cases, more information than is available in the 10-day compliance reports. Thus, a more refined preventability assessment can not be made with the available data. For purposes of this analysis, only the general discharge categories described above are identified as clearly "preventable."

Assessment of performance worse than the determined limits can not be done using the VI relief valve discharge performance data since reasons for discharges were not obtained in their survey. Instead, assessment of performance was done using regional compliance data where causes of discharges are available. However, there is a considerable overlap of plants represented in the VI survey and the regional compliance data. The attached Table 3 presents calculated plant performance for plants with relief valve discharge performance exceeding the recommended limits. Included in Table 3 are the actual plant relief valve discharge performance for the 12-month period in terms of number of discharges per 100 batches and number of discharges, number of discharges identified as preventable, causes of preventable discharges, and performance after elimination of clearly preventable discharges in terms of number of discharges per 100 batches.

As seen in Table 3, all of the plants for which causes of discharges are available can improve their performance to a level comparable to the recommended numerical limits by eliminating all identified preventable discharges.

EDC/VC Plants

Selection of the numerical limit for relief valve discharges at EDC/VC plants was based on a detailed evaluation of performance by one EDC/VC plant and on data in Table 2. As indicated in Table 2, recent relief valve discharge performance by the 10 VI-member EDC/VC plants ranges from 0 to 7 discharges per year. Performance by the remaining four plants not represented in Table 1 (i.e., not VI member companies) range from 0 to 5 discharges per year. Performance by the evaluated plant did not exceed 3 discharges in any recent 12-month compliance period. First, a numerical limit of 3 discharges per year was considered. For each plant with recent performance exceeding 3 discharges per year, reasons for poor plant performance (i.e., performance exceeding 3 discharges per year) were evaluated. As in the case of PVC plants, individual plant performance was calculated after identification and elimination of "preventable" discharges. The same criteria were used for identifying "preventable" discharges at EDC/VC plants as for PVC plants. Assessment of discharge reasons for plants with worse performance was done using regional compliance data on individual discharge reasons. Table 3 summarizes the calculated performance by plants after elimination of "preventable" discharges. Based on this analysis, it was judged that all plants could achieve a performance level slightly higher than the evaluated plant by eliminating "preventable" discharges. Thus, a numerical limit of 4 discharges per year was selected as an upper limit performance level representative of compliance with the current standard format for EDC/VC plants. Seven of the total 14 EDC/VC plants (50 percent) have achieved a performance level of 4 annual discharges or less since 1981.

TABLE 1. SUMMARY OF REGIONAL COMPLIANCE DATA

Plant Code	2/78-1/79	8/78-7/79	2/79-1/80	8/79-7/80	2/80-1/81	8/80-7/81	2/81-1/82	8/81-7/82	2/82-1/83	8/82-7/83
Suspension Reactor Discharges (Number of Discharges/100 Batches)										
R-1	0.04	0.059	0.039	0.043	0.024	0	0	0	0	0
R-2	0.017	0.016	0	0	0	0	0	0.031	0.031	0
R-3	0.011	0.011	0.022	0.059	0.079	0.026	0	0.011	0.024	0.01
R-4	(Plant start up 10/79)				0	0	0	0	0	0 0
R-5	0.02	0.02	0.058	0.062	0.013	0.084	0.070	0.011	0.024	0.02
R-6[a]	0.016	0.026	0.046	0.039	0.019	0.019	0.013	0.0083	0.017	0.032
R-7[a]	0	0	0	0	0	0	0.021	0.018	0	0.012
R-8[a]	0.01	ID	ID	ID	ID	ID	0	0	0	0.025
R-9[a]	0	0	0.032	0.036	0	0	0	0	0	0.01
R-10	0.015	0.022	0.021	0.024	0.026	0.027	0.036	0.028	0.020	ND
R-11	0.0083	0	0	0	0.020	0.020	0.030	0.021	0	ND
R-12	0	0	0	0	0	0	0	0	0	0
R-13	0.053	0.026	0.019	0.014	0.008	0	0	0	0	0
R-14	0.013	ID	ID	ID	ID	ID	ID	ID	0.018	0.016
R-15	0.013	ID	ID	ID	0	0.04	0.056	0.026	0.0091	0
R-17	0.008	0.008	ID	ID	ID	0.0094	0.0095	0.010	0.011	0.010
R-18	0.0087	0.0085	0.006	0.015	0.017	0.010	0.004	0.005	0.015	0.0066
R-19	0.32	0.21	0.064	0.094	0.12	0.080	0.11	0.085	0.015	ND
Dispersion Reactor Discharges (Number of Discharges/100 Batches)										
R-11	0.027	0.022	0.013	0.0095	0.021	0.009	0	0	0	ND
R-13	0.014	0.014	0.014	0.030	0.033	0	0	0	0	0
R-18	0	0	0	0	0.022	0.022	0	0	0	0
R-19	0.19	0.22	0.054	0	0	0.033	0.033	0	0.039	ND
R-8[a]	0.028	0.028	0	0	0	0.20	0.20	0	0	0
R-6[a]	0	0	0	0	0	0	0	0	0	0
Latex Reactor Discharges (Number of Discharges/100 Batches)										
R-11	0.067	0	0	0	0	0	0	0	0	0
Bulk Reactor Discharges (Number of Discharges/100 Batches)										
R-8[a]	0	ID	ID	ID	ID	ID	0	0.041	0.041	0.030
R-20	0.20	0.076	0.076	0.083	0.030	0.092	0.078	ND	ND	ND
R-21[a]	0	0	0	0	0	0.041	0.042	0	0	0
R-22	0.052	0.12	ID	ID	ID	ID	ID	ID	0.057	0.094

TABLE 1. (Continued)

Plant Code	2/78-1/79	8/78-7/79	2/79-1/80	8/79-7/80	2/80-1/81	8/80-7/81	2/81-1/82	8/81-7/82	2/82-1/83	8/82-7/83
Nonreactor Discharges (Number of Discharges/100 Batches)										
R-1	0	0	0.02	0.021	0	0	0	0	0	0
R-2	0	0.016	0.016	0	0	0	0.020	0.062	0.031	0
R-3	0.011	0.022	0.011	0.012	0.053	0.034	0.013	0.022	0.016	0.007
R-4	(Plant start up 10/79)			0.21	0.68	0.66	0.21	0.12	0.054	0
R-5	0.080	0.059	0.078	0.15	0.17	0.16	0.070	0.055	0.074	0.030
R-6[a]	0	0	0	0	0	0	0	0.0075	0.0075	0
R-7[a]	0	0	0	0	0	0.021	0.021	0	0	0
R-8[a]	0.017	0.033	0.016	0	0	0	0	0	0.012	0.0096
R-9[a]	0	0	0	0	0	0	0	0	0	0
R-10	0	0	0.007	0.007	0	0	0	0	0	ND
R-11	0.014	0.017	0.017	0.015	0.014	0.014	0.0086	0.003	0.003	0.003
R-12	0	~0.013	~0.013	0	0	0	0	0	0	0
R-13	0.027	0	0.004	0.024	0.021	0	0	0.0042	0.0042	0
R-14	ID	ID	ID	ID	ID	ID	ID	0	0	0
R-15	0	ID	ID	ID	0	0	0	0	0	0
R-17	ID	ID	ID	ID	ID	ID	0	0	0	0
R-18	0.026	0.019	0.009	0.007	0.004	0.004	0.012	0.014	0.023	0
R-19	0.071	0.039	0	0	0	0.0095	0.0096	0	0	ND
R-20	0	0	0	0	0	0	0	ND	ND	ND
R-21*	0	0	0	0	0	0	0	0	0	0
R-22	0.010	0.010	0	0.010	0.036	0.022	0	0.014	0.017	0
Solution PVC Process Discharges (Number of Discharges)										
R-23	1	2	2	1	0	0	0	0	0	0
EDC/VC Plants (Number of Discharges)										
RE-1	8	5	3	0	2	5	4	1	0	ND
RE-2	0	0	0	1	2	2	1	1	4	ND
RE-3							(Plant startup 11/82)			4
RE-4	0	5	5	7	8	1	ND	ND	ND	ND
RE-5	0	0	1	2	3	2	4	5	4	3
RE-6	1	3	5	4	2	4	4	3	ND	ND
RE-7	0	0	0	0	0	0	5	8	5	2
RE-8	2	2	2	1	0	0	0	1	1	0
RE-9	2	1	0	0	0	15	17	5	3	ND
RE-10	3	3	3	2	0	1	1	1	1	0
RE-11	5	6	4	1	2	3	1	ND	ND	ND
RE-12				(Plant startup late 1980)		2	2	2	0	1
RE-13	ND	ND	1	5	7	3	5	10	6	0

ND = No Data; 10-day reports not available.

[a]Plants visited.

TABLE 2. SUMMARY OF VINYL INSTITUTE DATA

Plant Code	Number of Discharges/100 Batches 8/81-7/82	2/82-1/83	8/82-7/83	Number of Discharges 8/81-7/82	2/82-1/83	8/82-7/83
PVC Suspension Reactor Discharges						
S-1	0.000625	0	Plant Down	1	0	Plant Down
S-2	0.0083	0.033	0.025	1	3	2
S-3*	0.032	0.032	0.025	1	1	1
S-4	0.0042	0.0042	0	1	1	0
S-5	0	0	0	0	0	0
S-6	0.00017	0.00017	0.00025	1	1	1
S-7	0.0083	0	0	1	0	0
S-8	0	0	0	0	0	0
S-9*	0.018	0	0.012	1	0	1
S-10	0	0	0	0	0	0
S-11	0	0	0.0109	0	0	3
S-12	0	0	0	0	0	0
S-13	0.067	0.101	0.059	7	10	6
S-14	0.033	0.033	0	1	1	0
S-15	0	0	0	0	0	0
S-16*	0.0083	0.017	0.034	1	2	4
S-17	0.017	0	0	3	0	0
PVC Dispersion Reactor Discharges						
D-1	0	0	0	0	0	0
D-2*	0	0	0	0	0	0
D-3*	0	0	0	0	0	0
D-4	0	0	0	0	0	0
D-5	0.0225	0.035	0.035	1	1	1
D-6	0	0	0	0	0	0
PVC Latex Reactor Discharges						
L-1	0	0	0	0	0	0
L-2	0	0	0	0	0	0
L-3	0	0	0.033	0	0	1
PVC Bulk Reactor Discharges						
M-1*	0	0	0.030	0	0	1
M-2	0.125	0.033	0	2	1	0
M-3	0.116	0.052	0.125	8	3	8

TABLE 2. (Continued)

Plant Code	Number of Discharges/100 Batches 8/81-7/82	2/82-1/83	8/82-7/83	Number of Discharges 8/81-7/82	2/82-1/83	8/82-7/83
PVC Nonreactor Discharges						
N-1	0.225	0.117	0.0833	12	7	6
N-2*	0.025	0.025	0.0083	2	2	1
N-3	0.168	0.275	Plant Down	2	1	Plant Down
N-4	0.10	0.0017	0	5	1	0
N-5*	0	0	0	0	0	0
N-6	0.005	0	0	1	1	1
N-7	0	0	0	0	0	0
N-8	0.0092	0.0092	0	1	1	0
N-9	0.0058	0.0083	0.0083	1	1	1
N-10	0.126	0.054	0.0433	2	1	1
N-11*	0.014	0.014	0	1	1	0
N-12	0.025	0.025	0	1	1	0
N-13	0	0	0	0	0	0
N-14	0	0	0	0	0	0
N-15	0	0	0.0056	0	0	1
N-16	0.020	0.020	0	1	1	0
N-17	0	0	0	0	0	0
N-18	0	0.017	0.017	0	1	1
N-19	0.0067	0.0108	0.0158	1	2	3
EDC/VC Discharges						
E-1	-	-	-	1	1	5
E-2	-	-	-	1	5	7
E-3	-	-	-	5	6	5
E-4	-	-	-	0	0	3
E-5	-	-	-	1	1	0
E-6	-	-	-	4	4	3
E-7	-	-	-	3	3	3
E-8	-	-	-	1	1	0
E-9	-	-	-	4	5	5
E-10	-	-	-	2	1	0

*Plants visited.

TABLE 3. ASSESSMENT OF PERFORMANCE WORSE THAN RECOMMENDED NUMERICAL LIMITS

Plant Code	Period	No. of Discharges / 100 Batches	No. of Discharges	No. of Clearly Preventable Discharges	Causes of Clearly Preventable Discharges	Performance After Elimination of Clearly Preventable Discharges
PVC Reactor Discharges						
R-19	8/81-7/82	0.085	6	4	1-operator error; 1-premature release; 2-recurrence	0.028 discharges / 100 batches
R-22	2/82-1/83	0.057	3	2	1-premature failure; 1-recurrence	0.019 discharges / 100 batches
R-22	8/82-7/83	0.094	6	4-6	Representative of this company indicated that most of the discharges were due to design problems. Appropriate modifications have been made.	<0.035 discharges / 100 batches
PVC Nonreactor Discharges						
R-2	8/81-7/82	0.062	2	1	1-operator error	0.031 discharges / 100 batches
R-4	8/81-7/82	0.12	2	1	1-operator error	0.06 discharges / 100 batches
R-4	2/82-1/83	0.06	1	1	1-operator error	0 discharges / 100 batches
R-5	8/81-7/82	0.055	5	2	1-operator error; 1-recurrence	0.033[a] discharges / 100 batches
R-5	2/82-1/83	0.074	6	3	2-operator error; 1-recurrence	0.037[a] discharges / 100 batches
R-5	8/82-1/83	0.030	3	1	1-operator error	0.020 discharges / 100 batches
EDC/VC Discharges						
RE-5	8/81-7/82	-	5	2	2-operator error	3 discharges/yr
RE-7	8/81-7/82	-	8	4	4-operator error	4 discharges/yr
RE-9	8/81-7/82	-	5	4	4-operator error	1 discharge/yr
RE-13	8/81-7/82	-	10	6	5-recurrence; 1-operator error	4 discharges/yr
RE-13	2/82-1/83	-	6	6	5-recurrence; 1-operator error	0 discharge/yr

[a] Level does not correctly reflect actual relief valve discharge performance by this plant since most relief valve discharges are flared. Flare destruction efficiency of VC is unknown. Typical flare destruction efficiency of other VOCs is at least 98 percent.

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

This document presents information on relief valve discharge performance by industries subject to the vinyl chloride (VC) NESHAP regulations. Information on relief valve discharge performance was collected as part of the review of the technological basis and administrative aspects of the current VC standard. The report includes relief valve discharge performance data for the entire compliance period following promulgation of the VC standard (i.e., 1978-1983). The information presented was based on Regional compliance reports, industry survey and plant visit.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Control National Emission Standards for Hazardous Air Pollutants Vinyl Chloride Polyvinyl Chloride Hazardous Air Pollutants	Air Pollution Control	13B

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